IYI-3 WHOI 1.1 Alvin

3. Legal right to submit to condemnation proceedings;
4. Payment for moving expenses or other losses not covered by appraised market value;
5. Occupancy during construction;
6. Removal of improvements;
7. Payments required from occupants of Government acquired land;
8. Withdrawals by owners of deposits made in court by Government;
9. Use of land by owner when flowage easement is acquired.

The above matters as well as the proposed schedule of land acquisition will be explained at the public meetings. There will be a question and answer period for general questions. A pamphlet covering various aspects of the land acquisition policy and procedures will be distributed to landowners, tenants and interested persons.

THE SUBMARINE "ALVIN"

Mr. MONDALE. Mr. President, the story of a small submarine named *Alvin* in the search for and the recovery of an H-bomb from a depth of 2,500 feet under the ocean offshore from the village of Palomares, Spain, parallels in many ways the recent orbit of the Gemini 8 spacecraft and its docking maneuver with the Agena.

Designed and built in Minnesota to perform oceanographic research, *Alvin* is a mobile, lightweight craft which can transport men to depths greater than those attainable by existing submarines and give them a capability for doing work.

The ideas, think, and experience of Allyn Vine, physical oceanographer at the Wood Hole Oceanography Institution—for whom the vehicle is named—were incorporated into the designs of an underseas vehicle.

Aerospace philosophy was here first applied to submarine design. An aeronautical engineer, H. E. Froehlich, experienced in the technology of stratospheric vehicle systems at the balloon capital of the world in Minneapolis, applied this knowledge to the *Alvin* project. He recognized the importance of the strong, yet lightweight structure required to develop a vehicle usable in vast areas of the world's oceans.

It was also important that the vehicle could be transported by plane to the work site in an emergency situation.

Through the foresight of the Office of Naval Research, submarine branch, then under Capt. C. B. Momson, Jr., a program was initiated through Woods Hole Oceanography Institution for the procurement of a research vehicle for deep ocean research in which designs and ideas conceived by the Applied Sciences Division of Litton Industries were incorporated. Under the aggressive leadership of Dr. Paul Fye, director, the institute became the first to acquire and become a user of a deep research vehicle for scientific research.

The remarkable submarine *Alvin*, developed and built by Litton Industries in Minnesota, is officially classified as a "deep submergence vehicle." It is a triumph of technical know-how and advanced industrial skills. *Alvin* has successfully performed research and study tests at depths below 6,000 feet. High intensity flood lights, a mechanical arm and complete maneuverability enable this two-man vehicle to accomplish a variety of under ocean assignments more than a mile below the surface. The hydrogen bomb search and recovery effort was a very sensitive and demanding job requiring outstanding skill and a precision and personal dedication of the crew. Minnesota is proud of its industrial contribution to technology, personified in this case by Litton Industries and *Alvin*.

TARIFFS AND RUBBER FOOTWEAR INDUSTRY

Mr. KENNEDY of Massachusetts. Mr. President, in little more than a year the Trade Expansion Act of 1962 will expire, and with it the President's authority to participate in multilateral negotiations for a substantial and general cut in tariffs.

The high hopes which accompanied enactment of this forward looking legislation have yet to be realized. Indeed, unless the Common Market soon gives concrete evidence of its desire to see these negotiations succeed, our hopes will be dashed, efforts to increase our markets for exports will be frustrated, and we are likely to face a resurgence of economic protectionism.

The success of the Kennedy round is therefore of great importance, both to this country and to the free world as a whole. The liberalization of trade it would bring about would promote the economic health of all the countries concerned and benefit firms and workers, as well as consumers.

However, it has long been recognized that a reduction in tariffs which clearly serves the national interest can be injurious to certain domestic industries which, despite expanding and increasingly efficient production, face serious competition from imports. The Trade Expansion Act of 1962 itself requires the President to pay particular attention to such industries before he decides to offer any tariff reductions.

Such an industry, in my judgment is the rubber footwear industry. This industry is vital to my State and provides employment to some 9,000 workers there. Imports of rubber footwear have over the past 10 years sharply risen and now account for almost 20 percent of the domestic market. More importantly, perhaps, the wholesale prices of the imports, which includes the amount of duty paid, are substantially below the wholesale prices of the domestic products, and in fact the retail prices of the imports are often below the wholesale prices of the domestic product.

The need to give the most careful consideration to the rubber footwear industry in the Kennedy round has been sharply underscored by what has already happened to this industry in the last year or so.

Last summer, rubber footwear gave up its fight to have Congress restore the American selling price method of valuation to synthetic rubber protective footwear, on the firm assurance that the executive branch would urge a uniform tariff of 60 percent for all rubber protective footwear, whether natural or synthetic. No soon did the industry drop its effort to have the American selling price apply to synthetics than the executive branch withdrew its assurance. That unhappy story was related to this chamber by the junior Senator from Connecticut, to whom the assurance of a 60-percent rate had been made, and who fought valiantly to have our Government honor its word. But what started as a 60-percent rate wound up as 37½ percent.

During congressional action on protective rubber footwear, the Treasury Department was reevaluating its method of applying American selling price to rubber footwear. Although for 30 years the Customs Bureau had consistently compared imported rubber footwear to its highest priced domestic counterpart, Treasury concluded that comparisons ought to be made with the lowest priced domestic counterparts. Earlier this year the Treasury Department began appraising imports of rubber-soled footwear with fabric uppers on this basis. This revision of appraisement practice has amounted to a unilateral tariff cut well in excess of 30 percent. And yet it is clear that this action was taken without consideration of the consequences of such a tariff cut on the economic health of the domestic industry.

I now understand that, while no firm decision has apparently been made, our negotiators in Geneva will shortly begin to explore the possibility of converting rate of duty based upon American selling price to equivalent rates of duty based on foreign or export value. It must be noted that such a negotiation cannot yield any quid pro quo to this industry, since it has long since lost its export markets to the Japanese.

However, and this brings me to my basic point, the rubber footwear industry views with the deepest concern the possibility of further tariff reductions, in excess of the unilateral reductions already suffered in the case of protective rubber footwear and rubber-soled footwear. It is convinced that not merely its economic health but its economic existence depends upon the maintenance of the existing tariffs, which themselves are already inadequate.

I share fully this concern of the rubber footwear industry. The data which I have seen raises a very serious question in my mind as to whether it would be sound policy for our negotiators to offer in the Kennedy round a change in the method of tariff valuation or reductions in the present rates of duty on rubber footwear.

I therefore urge most strongly that Governor Herter and his staff make an intensive economic analysis of the rubber footwear industry in terms of present conditions in that industry and in terms of the present tariff protection afforded it. If such an analysis reveals, as I believe it will, that rubber footwear industry would be seriously injured if further tariff reductions were to be made in the Kennedy round, then I would regard it as the obligation of Governor Herter's office and the White House to refrain from taking further action in the Kennedy round detrimental to this industry's interests.

Wabash River; and Helm Reservoir on Skillet Fork, the last two in Illinois. Local protection is proposed at Marion, Indiana. Public hearings have been held and basic design studies and cost estimates are essentially completed. Studies of multi-purpose use and coordination with the states and other Federal agencies are completed or well advanced.

The objective of the Third Interim Report is to meet some of the immediate needs of the basin for flood control, water quality control, recreation and other purposes. The proposed reservoirs are upstream type projects located near the head of tributary streams; scoped as multiple-purpose projects which will be compatible with comprehensive plans being developed for the Wabash River Basin.

3. *Schedule*. Interim Report Number 3 is scheduled for completion this summer and will be then reviewed and processed here in Washington for submission to Congress.

WABASH RIVER BASIN—NAVIGATION STUDIES

(For meeting with Senator HARTKE on April 29, 1966)

Our study of navigation on the Wabash was started late in 1964 and concerns the reach from the river's mouth to Terre Haute. The objective of the study is to determine whether a more detailed survey scope study, upon which Congressional action could be based, is warranted at this time. The present preliminary study is being carried on as a part of the Wabash River Basin Comprehensive Study.

During the past year, Colonel Roper, District Engineer at Louisville, Kentucky, contracted for and received a special study of coal resources in the Wabash Basin which might be tributary to the Wabash waterway. The District also made a field survey and conducted to survey by questionnaires to determine other commodities that would be susceptible to movement on an improved Wabash waterway. Information developed included origins and destinations of potential traffic. By comparison of transportation costs by the waterway and other available modes such as railway, they have made preliminary estimates of the volume of traffic that would utilize an improved waterway at this time, and estimates of the benefits that would be realized. In order to have the whole picture, however, the volume of future traffic that might use the waterway and benefits attributable to its movement must be estimated. These estimates are now being made.

The physical characteristics of the waterway we are presently considering between Terre Haute and the Ohio River are significantly different from those of the plan considered in 1932 for House Document 100, 73rd Congress, 1st Session. At that time the proposed route followed the river, which is only moderately intrenched in the broad and fertile Wabash Valley, and 18 locks and dams would be needed, with average lift of about 7 feet, to provide slack water navigation and avoid extensive inundation of the valley. From the standpoint of water transportation costs, delays associated with the 18 lockages would be very expensive, and the differential between waterway transportation costs and costs by other transportation modes would be reduced accordingly. To avoid this situation, the plan now under study would involve only six locks and dams and a considerable length of off-river channel. This plan would reduce the waterway length downstream from Terre Haute from 180 miles as considered in 1932 to about 130 miles. Cost of freight transport on the waterway under study would be substantially less than that with the 1932 plan.

To complete the present study requires a drawing together of transportation costs and benefits for all traffic anticipated during the 50-year economic life of the navigation project. This requires traffic projections which are complex and difficult to develop, and which will be subject to detailed review by our higher authority. Consideration will be given to recreation, fish and wildlife, water supply, water quality, hydro-electric power and other possible functions or effects of slack water development.

When our studies are completed for the section to Terre Haute, various decisions will be possible depending upon the study results. If results are very unfavorable, abandonment of all studies would be indicated. If the benefit-cost ratio is favorable, or only moderately unfavorable, survey scope studies to Terre Haute might be recommended, along with continuation of preliminary studies to Lake Erie or Lake Michigan, or both. If survey scope studies are recommended, additional funds will be required for necessary and extensive surveys and foundation exploration and more detailed engineering and economic studies.

I would like you to know also that the Wabash Valley Interstate Commission has retained an economist for the period February to August 1966 to consider the economic impact of navigation in the Wabash Basin and to estimate potential traffic that would move in the areas north of Terre Haute. We have been furnishing all pertinent information that is available to us to assist in those studies and our individual efforts have been fully coordinated.

WABASH RIVER BASIN—AVAILABILITY OF WATER ABOVE INDIANAPOLIS

(For meeting with Senator HARTKE on April 29, 1966)

The Wabash River Comprehensive Basin studies indicate steadily increasing demands for municipal and industrial water supplies. Pollution and water quality problems are serious at Indianapolis and upstream. These problems will become more critical in the future as the population and development of the area grow.

Reservoirs proposed in Interim Report Number 3 were considered for water supply for Indianapolis—Big Walnut, about 50 miles west of the city; Big Blue and Downeyville, about the same distance to the east. However, these would be expensive sources of water so that studies are now being made of sites upstream of Indianapolis on the White River.

These studies of the White River for water quality control storage and other purposes are being made on a fully coordinated and comprehensive basis. The problem is complicated by the limited drainage area and flow of the White River as compared with the needs of the area.

These problems of water supply and water quality are being coordinated particularly with the United States Public Health Service and the Wabash Coordinating Committee. Water availability above Indianapolis will be included in the final comprehensive report on Wabash River Basin scheduled for completion in 1969.

BRIEF DISCUSSION OF "JOINT LAND ACQUISITION POLICY" AND GENERAL LAND ACQUISITION POLICY OF THE CORPS OF ENGINEERS

(For meeting with Senator HARTKE on April 29, 1966)

Land for the reservoir projects will be acquired in accordance with the provisions of the "Joint Policies of the Departments of the Interior and Army, Relative to Reservoir Project Lands," which was published in the Federal Register of 22 February 1962, Volume 27, page 1734. This policy provides, generally, that fee title will be acquired to land lying below the top of the flood control pool plus a "freeboard", (generally 3 to 5 feet depending on whether the spillway is gated or ungated), which is the land needed to provide for the adverse effects of saturation, wave action and sloughing of the flood control pool. Where this freeboard does not provide a minimum of 300 feet horizontally from the top of the flood control pool, land will be acquired to encompass the 300 feet. Fee title will be acquired for such lands as are needed to meet present and future requirements for fish and wildlife as determined pursuant to the Fish and Wildlife Coordination Act. Such lands as are needed to meet present and future public requirements for outdoor recreation as may be authorized by the Congress will be acquired. Fee title will be acquired to the dam site area and to lands required for concentrated public use and access purposes.

The criterion for a minimum 300 foot strip horizontal from the top of the flood control pool elevation is an administrative determination which carries out the intent of the current Joint Policy. It ensures that adequate lands are available for the general public, and that the shoreline is not restricted by encroachment of adjacent landowners.

The "Joint Policy" provides for the acquisition of flowage easements rather than fee title in lands under all of the following four conditions:

a. Land lying above (upstream) from the storage pool (conservation, top of power pool, seasonal summer pool).

b. Lands in remote portions of the project.

c. Lands determined to be of no substantial value for protection or enhancement of fish and wildlife resources, or for public recreation.

d. It is to the financial advantage of the Government to acquire flowage easements rather than fee title.

The 300 foot criterion will not be applied in areas where significant development has taken place prior to availability of construction funds; where lands are devoted public parks, golf courses and cemeteries.

Flowage easements provide, generally, that the Government has the right to occasionally or permanently inundate or flood the land in connection with the operation of the project, for clearing the land, prohibit structures for human habitation, and the erection of any other structure without the approval by the District Engineer of the type and location of the structure.

Generally, oil, gas, and other mineral rights will not be acquired except where mineral development will interfere with the primary purposes of the project. However, mineral rights not acquired will be subordinated to the operation of the project. This permits the development of the mineral interests in such manner as not to interfere with project operations. The District Engineer will approve the type and location of structures for the development of the mineral interests.

Acquisition of land for public use and access is authorized by the Flood Control Act of 1944 as amended. Access in such circumstances is not limited to a road terminating at the water's edge. Access areas must provide for parking of automobiles and land necessary for health and sanitary facilities. Public access areas are determined after coordination with national, state and local organizations giving consideration to the estimated number of visitors to the lake, proximity of centers of population and the road network which will provide access to the areas.

Public Law 86–645 provides that within a reasonable time after the initial appropriations are made for the construction and land acquisition for a project, the Corps of Engineers will hold public meetings in the vicinity of the project for the purpose of disseminating the following information:

1. Factors considered in making the appraisals;

2. Desire to purchase property without going to court;

Vine
Ocean
HK sent picture &
editorial from
record

WHOI 2,1

Ma
April 1, 1966

Dr. Allyn Vine
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts

Dear Allyn:

Here is a copy of the picture we had taken while you were last here. I think it turned out rather well.

Also enclosed is a copy of the Editorial from the Cape Standard, which I had included in the Record recently.

By the way did you see any part of the tape we did on TV? And if so, what did you think?

Best regards,

Sincerely,

HASTINGS KEITH
Member of Congress

HK:jn
Enc (2)

[From the Newberg (Oreg.) Graphic]

WATER AND NEED

With the Columbia River carrying more water than practically any river in the world, California and Arizona Congressmen are turning envious eyes toward the Northwest.

It has been estimated that a waterflow approximate to the Willamette's at Salem, would give California and Arizona all the water they would need. Considering the Columbia's volume (which has a more even flow month in and month out than most other rivers) this much water would hardly be missed.

Biggest danger seems to be to fish life and if this could be solved we think it would be a wonderful scheme to transport some of our surplus water to the arid southwestern regions. After all, the U.S. Constitution forbids States to set up barriers against each other. This is one country and all parts are independent on each other.

Columbia River water, flowing south to California and Arizona, would be a tremendous boon to the arid eastern Oregon country as well. The water situation isn't going to get any better * * * it will get progressively worse. We hate to see any area deprived of water simply because a few politicians (Democrats and Republicans alike) want to make an issue out of it. If the Columbia River fishery is not endangered, let's get on with the biggest water project the world has ever known.

"Alvin" Is Making History

EXTENSION OF REMARKS

OF

HON. HASTINGS KEITH

OF MASSACHUSETTS

IN THE HOUSE OF REPRESENTATIVES

Tuesday, March 29, 1966

Mr. KEITH. Mr. Speaker, we have been following closely the search for the hydrogen bomb in the coastal waters off Spain. A small research submersible Woods Hole Oceanographic Institution finally located the bomb and is now assisting in recovery operations. The vehicle, *Alvin*, is named for Allyn Vine, the Woods Hole engineer who played a key role in developing the submersible.

As one who has long advocated that investment in our oceanographic program would be highly profitable for the United States, I am pleased that this research vessel is of so much assistance to the Navy in a matter of critical importance to our national security. This incident will perhaps point up some of the potential value of developments in oceanography as well as give some indication of the need for us to possess adequate technology to explore the seas.

The Cape Cod Standard-Times recently published an editorial which, in my view, sums up the situation very well. It praises the *Alvin*'s capabilities, pointing out that those involved in its design and manning have helped to make history. Yet the article makes the point as well that we must recognize that the *Alvin* is only the beginning of a new era in ocean technology.

THE "ALVIN"

There could have been those who eyed askance the submarine *Alvin* when it first arrived in Woods Hole waters.

It was such a small craft—and there were so many things being said about what it could do in the matter of deep sea diving and research.

The *Alvin* underwent its tests and performed successfully. Yet—

Whatever doubts there might have remained about the usefulness of the *Alvin* were dispelled when the deep submergence research vessel last week located a hydrogen bomb missing off the coast of Spain following an air mishap involving U.S. planes.

Attention around the globe had been focused on the search.

Down went the *Alvin*—and it scored another success.

Men have been deeper than 2,500 feet below the surface—the depth at which the hydrogen bomb was discovered. The *Alvin*, in fact, has been down more than double that depth while manned.

The *Alvin* is maneuverable; it can move up and down, forward and backward and hover at great depths. That combination was not possible too long ago.

Let it be said that the *Alvin* has done itself proud off Spain. Let it be said that those who manned the craft in its dives and tests and created its design and equipment have helped make history.

There will be others coming along like the *Alvin*, which represents a new generation of underwater vessels. Science, and man's inventiveness, in the days to come, doubtless will make the *Alvin* obsolete.

But, for now, the *Alvin* deserves the admiration being heaped upon its tiny self.

Representative Charles S. Gubser Supports Public Law 874

EXTENSION OF REMARKS

OF

HON. CHARLES S. GUBSER

OF CALIFORNIA

IN THE HOUSE OF REPRESENTATIVES

Tuesday, March 29, 1966

Mr. GUBSER. Mr. Speaker, today I testified before the General Subcommittee on Education in opposition to a proposal by President Johnson which would seriously curtail the benefits to education of Public Law 874 and Public Law 815, which have worked so effectively since 1950.

TESTIMONY OF THE HONORABLE CHARLES S. GUBSER, IN SUPPORT OF PUBLIC LAW 874, BEFORE THE EDUCATION SUBCOMMITTEE, MARCH 29, 1966

Mr. Chairman and members of the committee, as President Johnson has stated in the past few months, "the education of our people is a national investment. There is no greater challenge than that of providing our children and youth with the opportunity to develop fully their talents and interests. Education is vital to the achievement of a Great Society and is our major weapon in the war on poverty."

It is difficult to reconcile these admirable and well-accepted views with the current proposal to amend Public Law 874 and Public Law 815.

William Carey, Executive Assistant Director of the Bureau of the Budget stated in a recent letter that "the reduction in the impacted area program is * * * a reflection of the hard choices which are necessary to meet critical domestic needs in a time of extraordinary requirements for our international commitments."

Yet President Johnson does not find it difficult to dim his enthusiasm for education—and logic—to the point where he will sacrifice $190 million in funds for a well-proven, successful program at the same time that he requests about nine times as much—$1.75 billion—to finance his poverty program which all too often has turned into an administrative tangle embroiled in local feuds and is, as Chairman ADAM CLAYTON POWELL commented on March 8, "mired in the swamp of mediocrity."

Furthermore, it is simply not true that new educational assistance programs will make up for the loss in Public Law 874 funds.

Money under the Elementary and Secondary Education Act of 1965 goes to districts with large numbers of low-income families and must be spent in a specific way for additional programs superimposed on the educational program already being sustained. Public Law 874 funds generally go to entirely different districts—those that have more students than normal due to tax-exempt Federal Government activities in the area. It is one of the few programs which assist the local taxpayer in meeting day-to-day operating costs of the regular school program. Any loss here will mean reductions in basic school programs.

It is significant that Federal control under Public Law 874 and Public Law 815 has been kept to a minimum, a goal which this Committee and the Congress has often stated. No other form of Federal assistance has produced so little erosion of local control.

My district is strongly opposed to any change in Federal aid to impacted school districts. As one person put it, "The caliber of people brought here by Federal aerospace and electronic activities demands a high level curriculum taught in good schools. We have been making giant strides, and thus far we have been able to provide this curriculum. Loss of Public Law 874 funds would present an enormous crisis to our district. Our taxpayers are already heavily burdened to keep up our schools. We would prefer that less money be spent on the programs of the Great Society and antipoverty programs as a means of economizing."

There is great justification for upgrading the level of education of the disadvantaged who live in areas of poverty. Such an improvement is unquestionably an addition to our national assets.

But we all agree that the objective of education must go beyond bringing the disadvantaged up to a norm. It must also concentrate on the very fertile minds of those whose backgrounds have blessed them with special aptitudes. Here is our source of scientists, technologists, and intellectuals who will be leaders of tomorrow and whose skills can build a better life for all—rich and poor alike.

It is a fact of life that students with these aptitudes are often concentrated in areas of Federal impaction. We cannot afford in this crucial time of technological and ideological competition with the Communist world to cut back on the accelerated educational programs which we now offer talented and superior students. Yet this would be the inevitable result of the President's recommendations regarding Public Law 874.

Eighteen school districts in my congressional district will receive approximately $1,485,450 this year under the terms of Public Law 874. Under pending administration proposals, only nine districts will receive $207,766 for a net loss of $1,277,684.

Under California law, the State will automatically assume from the State school fund an average of 25 percent of the Federal cutback. The State fund, however, is already showing a deficit for this year. As a result these make-up funds may not be available, and the current budget crisis which the California legislature is facing increases this likelihood. This deficit and the loss caused

by the Federal cut will result in reduced State equalization which is paid to most school districts in the State—not just to those receiving Federal funds.

In addition, the districts receiving Public Law 874 and Public Law 815 funds are not rich in terms of local tax dollars. Most of them are at the maximum tax rate allowed by law and are bonded to their legal capacity. In almost every case the districts will have to turn to the State for additional help beyond the amount they will receive automatically. If this help is to be forthcoming it will require special action of the legislature and will be an additional burden on the State taxpayer.

Dollarwise, local schools will take a drubbing if Public Law 874 is not continued as it is.

It cannot be said that the loss of Public Law 874 and Public Law 815 aid will be offset by application of the Elementary and Secondary Education Act. Since this is a law with nationwide application, its benefits and provisions are now available to all school districts and its application should be nondiscriminatory. But if, because of this newest law some school districts are forced to surrender the payments they have received for a Federal impact which has narrowed the local tax base, then those districts are the victims of discrimination. They are prevented from taxing a Federal installation which contributes children who must be educated at partially local expense and they receive no more, probably less, Federal aid. In the sense that local citizens are asked to shoulder what is properly a Federal responsibility, they are the victims of discrimination.

I strongly support continuing Public Laws 874 and 815 as they are presently written because the programs have been successful and have involved a minimum of Federal regulation, because of the bonafide need the programs are designed to meet, and because their maintenance will prevent discrimination between school districts.

One hundred and ninety million dollars is such a small commitment to the education of tomorrow's leaders.

Child Abuse

EXTENSION OF REMARKS

OF

HON. WILLIAM S. MOORHEAD

OF PENNSYLVANIA

IN THE HOUSE OF REPRESENTATIVES

Thursday, March 17, 1966

Mr. MOORHEAD. Mr. Speaker, I am advised that the conferees on H.R. 10304 to provide mandatory reporting of child abuse in the District of Columbia will meet soon to work out differences between the Senate and House bills. The Congress, hopefully, therefore, will take final action this year in dealing with the child abuse problem here in our capital city.

This is, of course, a nationwide problem but it is a problem with which local authorities in the various States must deal. Since the Congress has not yet given up its responsibilities as "City Council" for the city of Washington, I think it is imperative that we do enact this legislation for the District of Columbia this year.

The distinguished medical writer for the New York Times, Dr. Howard A. Rusk, on March 27 wrote an excellent survey article entitled "The Battered Child." His article points out, among other things, the important research and demonstration projects carried out in this field by the Children's Bureau under the direction of its very able chief, Mrs. Katherine B. Oettinger.

Under leave to extend my remarks, I include Dr. Rusk's article at this point in the RECORD.

THE BATTERED CHILD: PARENTAL ABUSE OF YOUNGSTERS IS THE FOCUS OF FOUR FEDERAL RESEARCH PROJECTS

(By Howard A. Rusk, M.D.)

In the last few years a terrifying and ugly new phrase has entered the medical lexicon—the "battered child syndrome."

It is understandable that professional concern for the plight of children who are mistreated physically by their parents has increased in recent years. However, it is not known whether the prevalence of such incidents is actually increasing.

Physical punishment of children by parents has been accepted through the ages. When a parent inflicts injury in reprimanding a child, it then is termed abuse. Determination of what is abuse is decided by the courts.

Because a physician is frequently the only person outside of the parent who sees the abused child, he must be suspicious if certain symptoms are evident. Among them are indications of neglect, evidence of broken bones, internal injuries, including brain damage, and soft tissue injuries.

The diagnostic role of the radiologist is often a key one. It is the radiologist who may first find fractures or obscure internal injuries. This evidence of trauma alerts the physician to investigate the cause, which may be criminal abuse.

The radiologist may also be the key to disposition of the case, because if he can build up the necessary evidence while the child is in the hospital, the parents may be called in and may, faced with that evidence, acknowledge responsibility for the injuries.

The physician must not only feel free but also feel a moral responsibility to report any cases of child abuse he suspects. This should be done promptly because parents who abuse their children often shift physicians when second injuries occur.

The physician, as a result, is often reluctant to report child abuse cases because of the possibility of misinterpretation when having examined the child only once.

The physician also often hesitates to report such cases because of the right of privileged communication in this instance is a disclosure of a conversation between physician and parent and is protected by law.

The attorney general of Kansas, however, has suggested that the right of privileged communication does not extend to parents if a physician is called to testify. He argues that the child is the actual patient.

Assistant U.S. Attorney Timothy Murphy has pointed out it is much better for authorities to work informally with parents and to get them to accept whatever help social and psychiatric agencies may be able to offer than to prefer charges. Mr. Murphy handles such problems in the District of Columbia.

He points out that the vast majority of children are ultimately going to end up back home with the same set of parents. He also stresses that it is difficult to get a conviction and that indicting without convicting is no deterrent to further abuse.

Conviction cannot be based on the evidence of a child alone, as the testimony of children under 7 years old is not held competent by the courts, nor can be husband and wife be compelled to testify against each other.

In cases analyzed, mothers appear to be the abusers in the majority of instances. Psychiatrists say that this confirms the knowledge that emotional disturbances are often triggered in the postpartum period, the time immediately after the birth of a child, when the mother often suffers from despondency and anxiety.

These mothers have not fully grasped the experience of childhood or motherhood and are, therefore, often unable to assume parental responsibilities.

Physical abuse of children may also be an expression of the parent's failure to distinguish between their own childhood suffering and their reaction to other children. In one case, a parent told of his alcoholic father who had beaten and tyrannized him during childhood. The man's parents separated and he never saw his father again. This man saw his son in the same light as his childhood relationship with his father.

A sergeant in the military police spoke of his 9-month-old son, whom he had beaten: "He thinks he's boss—all the time trying to run things—but I showed him who's in charge here."

Studies have shown that physical abuse of children is no more evident in one ethnic, social, or economic group than in another. In only a few instances did gross poverty or ignorance appear.

The only common denominator seems to be that the child beater is determined to take out personal frustrations on one or more of his children because of the lack of emotional maturity to deal with his own conflicts.

Currently, the Children's Bureau of the Department of Health, Education, and Welfare is supporting four research and demonstration projects aimed at finding out why parents abuse their children.

Mrs. Katherine B. Oettinger, Chief of the Children's Bureau, comments:

"Each of these projects represents a different approach to a very complex problem—ranging from a project to collect nationwide data on the incidence of child abuse to an analysis of how protective services of child welfare agencies are used in cases of neglect and abuse."

The projects are at Brandeis University, Waltham, Mass.; the Juvenile Protective Association, Chicago; the University of Pennsylvania School of Social Work, Philadelphia, and the School of Social Welfare, University of California, Berkeley, Calif.

Whereas, 5 years ago only one State had child-abuse statutes, the reporting of physically abused children has now become almost nationwide. Laws existed at the start of this year in all States except Hawaii, Mississippi, and Virginia.

Most of the legislation is patterned on recommendations developed by the Children's Bureau in 1963.

The philosophy of treating the battered child as a health problem calls for rehabilitation rather than punishment of the parent. These parents are sick people. However, they must first want to receive treatment and get well.

Unless we recognize the emotional health of the parent as the key factor and orient the legal solutions of that issue, the problem of child abuse will never be solved satisfactorily.

Popper Goes North

EXTENSION OF REMARKS

OF

HON. RALPH J. RIVERS

OF ALASKA

IN THE HOUSE OF REPRESENTATIVES

Wednesday, March 2, 1966

Mr. RIVERS of Alaska. Mr. Speaker, where "there's a will, there's a way"—and our VISTA volunteers have a fund of

Alvin is Making History

Extension of Remarks

of

HON. HASTINGS KEITH

IN THE HOUSE OF REPRESENTATIVES

Tuesday, March 29, 1966

Mr. KEITH of Massachusetts. Mr. Speaker, we have been following closely the search for the hydrogen bomb in the coastal waters off Spain. A small research submersible from Woods Hole Oceanographic Institution finally located the bomb and is now assisting in recovery operations. The vehicle, Alvin, is named for Allyn Vine, the Woods Hole engineer who played a key role in developing the submersible.

As one who has long advocated that investment in our oceanographic program ~~will~~ would be highly profitable for the United States, I am ~~gratified~~ pleased to ~~hear~~ report that ~~a civilian~~ this research vessel ~~can be~~ is of so much assistance to the Navy in a matter of critical importance to our national security. This incident will perhaps point up some of the potential value of developments in oceanography as well as give some indication of the need for us to possess adequate technology to explore the seas.

The Cape Cod Standard Times recently published an editorial which, in my view, sums up the situation very well. It praises the Alvin's capabilities, pointing out that those involved in its design and manning have helped to make history. Yet the article makes the point as well that we must recognize that the Alvin is only the beginning of a new era in ocean technology.

WHOI 4.1

Mr. Keith talked with Dr. Paul Fye at Woods Hole today, March 18th, with reference to ALVIN. He explained that he would like to do a film - for television - with Allyn.

Fye said the ALVIN was down for eleven hours - and has gone back down to run a message line. The first time she came up, the LUMONAT relieved her on the spot.

A briefing was held in Admiral Swanson's office this morning.

Fye said that AP had called him and said reliable sources in Spain have indicated that it is the atomic bomb.

Fye said that Woods Hole should certainly get the credit for the ALVIN. And, that Vine should have some credit.

Fye agrees with the Secretary's office that they should be sure before they go ahead. He had talked with Capt. Snyder - and Snyder is supposed to call him back. Snyder said they are considering a press conference - and getting some people back from Spain.

The Boston Television channels did give Woods Hole and ALVIN specific credit.

Dr. Fye called Mr. Keith just before noon - Capt. Snyder had called and said they can give out ALVIN capabilities and pictures. State Department is sitting on it. Fye asked Snyder for a release on the facts as they know them. Snyder doesn't know if they will make a release until after identification.

WHOI 4.2

CREW OF ALVIN

William Rainnie - chief pilot

Earl Hayes - chief scientist

Marvin J. McCamis

Valentine Wilson

There are three pilots - making two dives and skipping one.

Total of 12 people from Woods Hole.

LUMONAT operates mostly out of Miami. Owned by Reynolds International.

ALVIN was built by the Navy for Woods Hole Oceanographic Institute.

The crew of the ALVIN all reside in Woods Hole.

WHOI 5-1

(From the Cape Cod Standard Times, March 24, 1966)

The Alvin

There could have been those who eyed askance the submarine Alvin when it first arrived in Woods Hole waters.

It was such a small craft — and there were so many things being said about what it could do in the matter of deep sea diving and research.

The Alvin underwent its tests and performed successfully. Yet —

Whatever doubts there might have remained about the usefulness of the Alvin were dispelled when the deep submergence research vessel last week located a hydrogen bomb missing off the coast of Spain following an air mishap involving U.S. planes.

Attention around the globe had been focused on the search.

Down went the Alvin — and it scored another success.

Men have been deeper than 2,500 feet below the surface — the depth at which the hydrogen bomb was discovered. The Alvin, in fact, has been down more than double that depth while manned.

The Alvin is maneuverable; it can move up and down, forward and backward and hover at great depths. That combination was not possible too long ago.

Let it be said that the Alvin has done itself proud off Spain. Let it be said that those who manned the craft in its dives and tests and created its design and equipment have helped make history.

There will be others coming along like the Alvin, which represents a new generation of underwater vessels. Science, and man's inventiveness, in the days to come, doubtless will make the Alvin obsolete.

But, for now, the Alvin deserves the admiration being heaped upon its tiny self.

WHOI 7-1

Alvin Readied for Deep Dives off Bermuda Coast

CC S-T

WOODS HOLE, July 29 — Oceanographic institution's deep-diving submarine Alvin is scheduled to resume a series of research dives off the Bahamas.

The sub previously had made a number of dives, including tbree in waters up to 6,000 feet, the maximum depth the prototype craft can descend, in dives off Bermuda.

Alvin is conducting underwater structure surveys and taking photographs in conjunction with the institution's geological department.

It is the first time the sub, a prime implement in the recovery several months ago of a lost nuclear bomb off the coast of Spain, has been used for research work by the institution.

Piloting the craft are Chief Pilot William O. Rainnie and Marvin J. McCamis and Valentine P. Wilson. The trio also manned the sub during the widely-acclaimed bomb hunt.

The three men spent last weekend in Falmouth and then flew back to the Bahamas to continue the research program.

Alvin, which left Woods Hole June 24 aboard her 96-foot catamaran barge, is not due to return here until later this Summer.

Meanwhile, the research vessel chain is scheduled to dock in Lisbon, Portugal today where Dr. Edward F. K. Zarudzki is scheduled to assume the duties of chief scientist.

Dr. Earl E. Hayes has been head scientist on the cruise, devoted to acoustical, geophysical and geological studies. Chain is not scheduled to return to Woods Hole until December.

Research vessel Atlantis II, meanwhile, is continuing its velocimeter studies in the waters off Bermuda and is not due in Woods Hole until Aug. 11. Chief scientist is Richard E. Payne.

Sub Finds H-Bomb Off Spain

3-17-66

Weapon Reported Intact in Water 2500 Feet Deep

PALOMARES BEACH, Spain, March 17 (AP)—The U.S. midget submarine Alvin has found the hydrogen bomb that was lost two months ago in an American bomber-tanker plane crash over Spain, official sources said tonight.

They reported that it was sighted with its parachute still attached 2500 feet under the Mediterranean Sea, five miles offshore. The weapon was apparently intact — indicating no lethal leakage in the waters of this resort.

Officials said it would take up to three days for Rear Adm. William Guest's Task Force 65 to bring the bomb ashore or put it aboard a search vessel. Warships ringed the area and recovery operations were expected to start Friday morning.

The official sources said the Alvin found the weapon Wednesday. Directors of the search were just settling down to a long sweep of the sea bottom when word of the contact was flashed from the sub.

Angier Biddle Duke, U.S. Ambassador to Spain, called off a hastily scheduled midnight news conference in Madrid, but an Embassy official said this was not "in any way a negation of the information I know you already have. We are just not yet in a position to speak officially . . . If we have positive identification and recovery we will so inform you."

It was understood that for reasons of diplomatic courtesy, it was considered preferable for the official announcement to come from the Spanish government.

Experts who looked at photographs taken by the Alvin said there was no doubt the object found was the bomb. They said the pictures show the bomb, intact in its casing, and the attached parachute.

Officials said no pictures would be permitted of the bomb, the parachute or re-

See BOMB, A8, Col. 1

BOMB—
From A1

U.S. Sub Finds H-Bomb Off Spain

covery operations because of their highly classified nature.

Howard Simons, science writer of The Washington Post, reported from Cape Kennedy, Fla.:

American officials' optimism that the bomb has been found is based on photographs of a parachute shrouding an object presumed to be the bomb, which is resting precariously on a slope of the Mediterranean Sea floor a few miles off Palomares. The location has been a prime suspected site for the missing weapon that fell along with three others after the collision over Palomares.

Preparations for recovering the parachute and whatever is beneath it already have begun. Top American officials are already on the scene in anticipation. Gen. Stanley Donovan, chief of the U.S. military mission in Spain, flew to Palomares from Madrid yesterday.

Recovery promises to be a delicate operation, informed sources said.

These same sources point out that not only is the parachute-shrouded object already in deep water, but apparently it is balanced on the slope in such a way that a wrong nudge could send it rolling into even deeper water.

In addition to the evidence of the photographs, whatever it may be, the location of the object and other clues account further for the optimism among officials.

The object is resting about des the missing bomb would accid parachute had fully jectured the time of the from the mine experts con- tail plate 's para-

The Washington Post March 18, 1966

chute had been found soon after the accident.

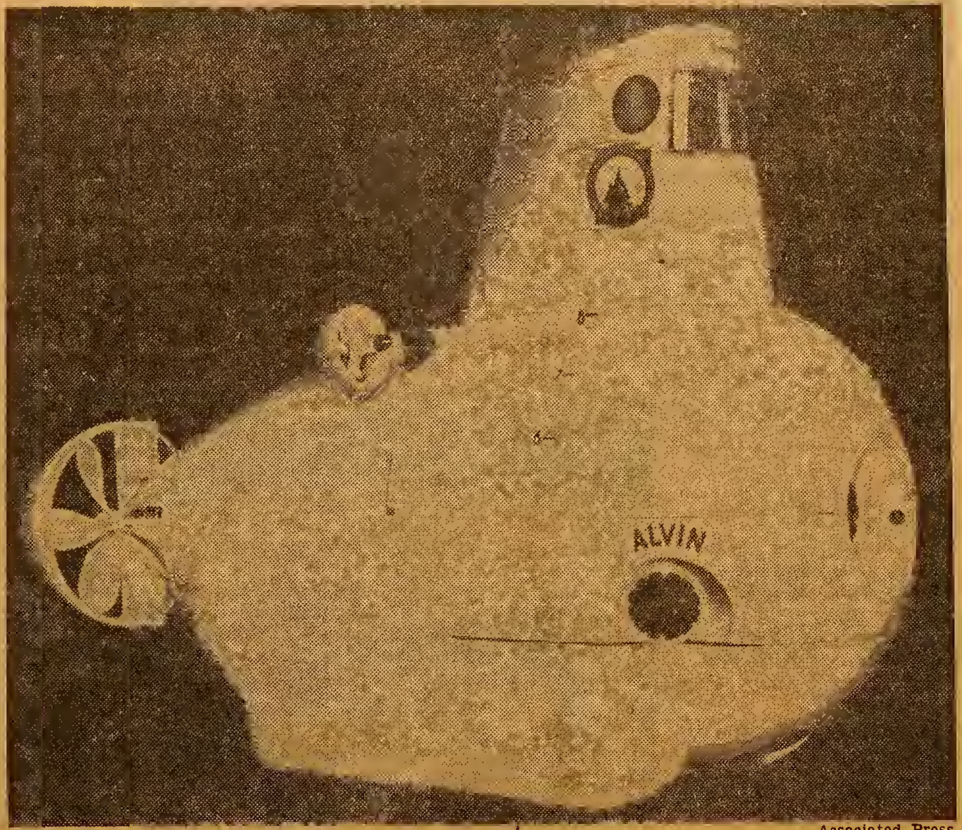
Moreover, the photographs of the parachute off the coast fit a Spanish fisherman's account of seeing an object on a parachute plummet into the sea just after the midair collision.

Recovery of the missing bomb presumably would bring to an end the intensive and expensive search for it that has been made on land and under the sea since the crash.

This will not end the Palomares incident, however. There still are claims to be settled with the villagers, whose farmland, crops and animals were dusted with small amounts of radioactive plutonium when two of the unarmed weapons had high-explosive detonations upon impact.

Then, too, the United States will still have to counter Russia propaganda about the incident.

Finally, it is not inconceivable that the United States will try to renegotiate strategic bomber refueling rights over Spain—rights Spain took away at the time of the incident.



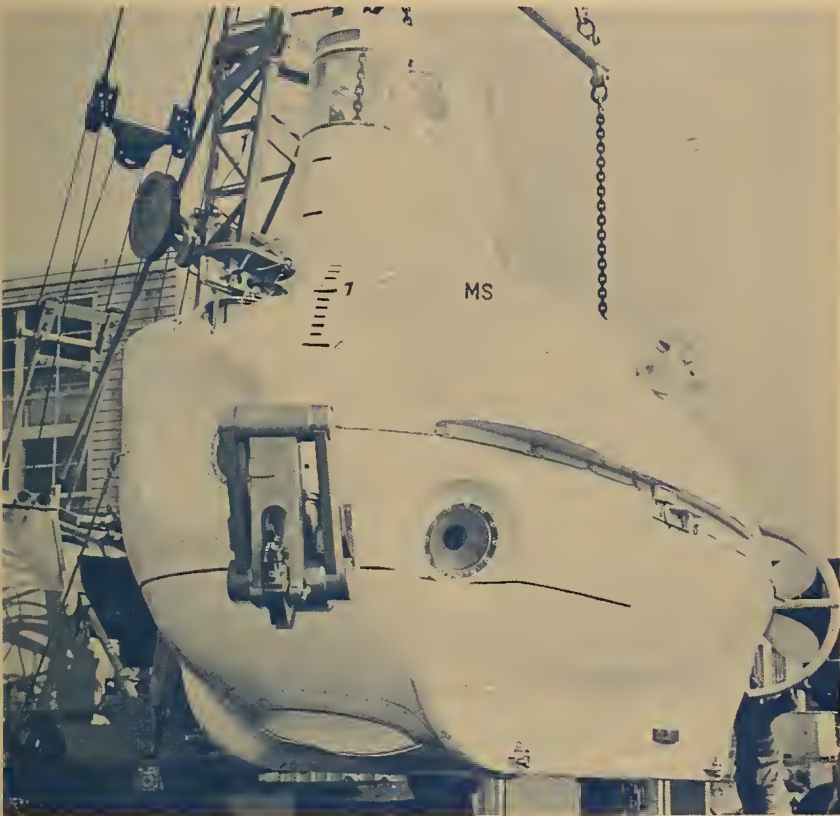
Associated Press

SLEUTH—This is Alvin, the midget submarine that found the H-bomb off Spain.

DEEP SUBMERGENCE RESEARCH VEHICLE

ALVIN

The Woods Hole Oceanographic Institution
Woods Hole, Mass.



ALVIN is the culmination of the efforts of many persons — the research scientists who insisted that they be able to examine by direct observation the depths of the seas, the engineers and the technicians whose skills have made its construction possible, and those in the Office of Naval Research who are determined that the United States Navy shall be better able to defend our country through greater knowledge of the oceans.

Paul M. Fye
Director

ALVIN

ALVIN is a deep diving research vehicle designed specifically for oceanographic research. Its existence marks the successful fulfilment of untiring efforts on the part of many people in research laboratories, industry and the Federal Government, to provide marine scientists with a means of descending safely into the oceanic environment to view first hand the objects they have been studying from afar. The need for a vehicle of this type has been recognized by the scientists of Woods Hole Oceanographic Institution and other marine laboratories for some time. Funds and inspiration for its construction were provided by the Office of Naval Research. The Bureau of Ships of the U. S. Navy assisted in the preparation of performance specifications for its design and construction, and the Applied Sciences Division of Litton Industries (formerly the Electronics Division of General Mills, Inc.) designed and built the vehicle.

Major Features

The vehicle is 22 feet long, has an 8-foot beam, displaces 13 long tons, and has a draft of 8½ feet in 'surfaced' condition. It is designed to have a top speed of 6 - 8 knots, a cruising speed of 2.5 knots and a range submerged of 20 - 25 miles. Its design operating depth is 6,000 feet with a safety factor of more than 1.8. The 7-foot diameter pressure sphere is made of high strength steel, 1.33 inches thick. There is room in the sphere for a pilot and one or two observers, together with instrumentation and life-support equipment which will provide an endurance of twenty-four hours or more. Four viewing ports permit the pilot and observer to see ahead of and beneath the vehicle. The only openings in the hull are the hatch and an emergency sphere release. All other connections between the inside and outside of the sphere are electrical, with the wires passing through specially designed fittings. The power for the vehicle comes from three banks of lead-acid batteries located in packages which may be dropped in an emergency.

The vessel is propelled by three propellers controlled by a "joy stick" from inside the sphere. There is a small lift propeller on each side which can be rotated so as to direct its thrust up or down, ahead or astern. A large propeller is located at the stern. The stern propeller

can be turned from side-to-side to steer the vehicle in the same manner that an outboard motor is turned to steer a conventional small boat. The two lift propellers are separately reversible to provide increased maneuverability; the vehicle can turn on its own axis by reversing one and going ahead on the other. All the propellers are driven by reversible hydraulic motors powered by hydraulic pumps which are driven by electric motors encased in oil. All these components are located outside the pressure sphere.

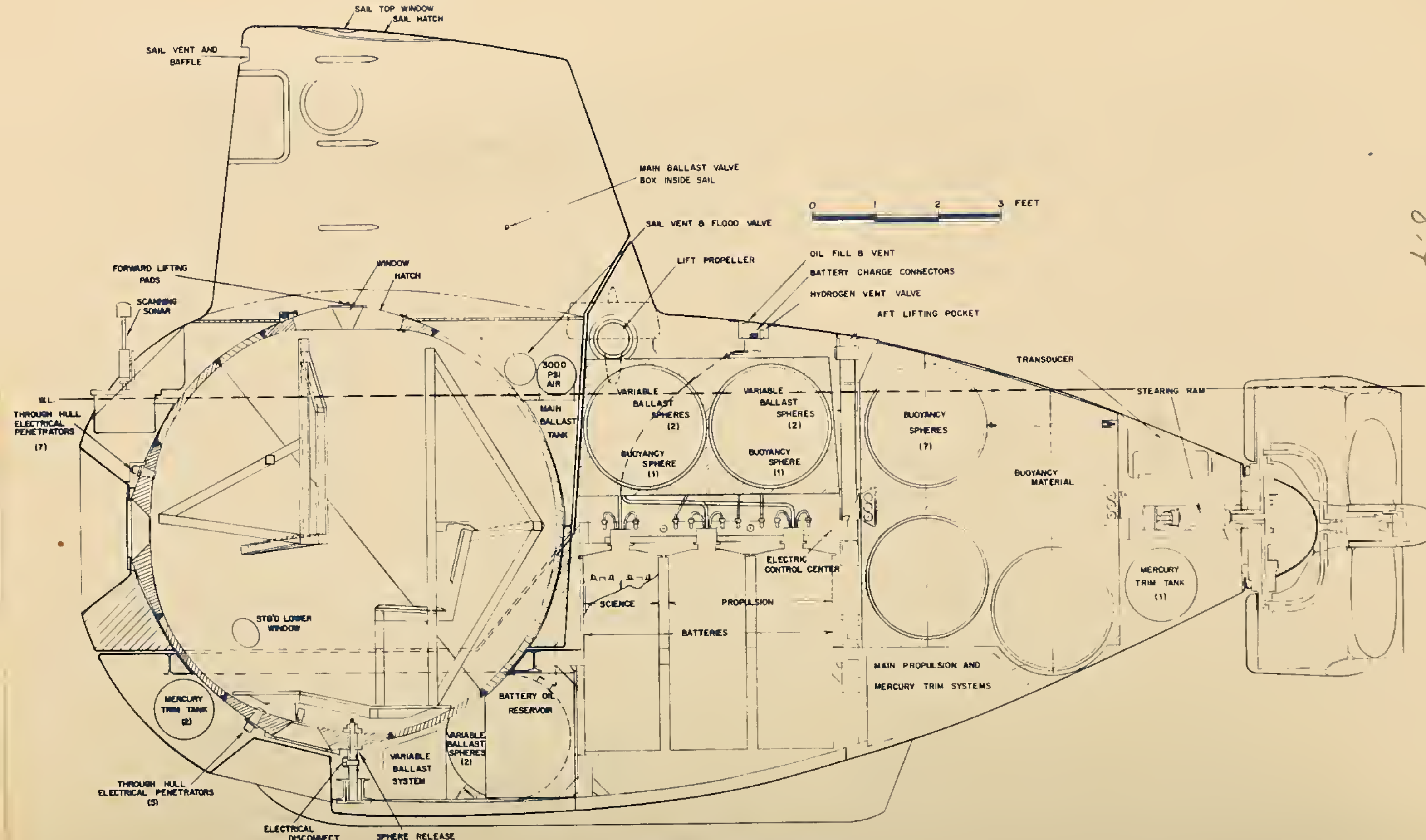
To control fore and aft angles of the vehicle, a mercury trim system is installed. This consists of two trim tanks, one located near the bow and the other in the stern. These tanks are half filled with mercury and half with oil. The tops and bottoms of the two tanks are connected with piping so that as oil is pumped from the top of one tank to the top of the other, mercury is forced from the bottom of that tank into the bottom of the first. Thus, fore and aft trim angles up to about 30° are possible.

To compensate for differences in the weight of personnel and instruments carried and for changes in the density of sea water, a variable ballast system is included in the vehicle. This system utilizes inter-connected pressure-proof aluminum spheres and collapsible rubber bags which are partially filled with oil. As oil is pumped from the spheres into the rubber bags, the amount of sea water actually displaced by the vehicle is increased (thus increasing the buoyancy) while the weight of thc vehicle remains the same. The effect is to make the vehicle "lighter." When oil is pumped from the collapsible bags into the spheres, the vessel becomes heavier. It is therefore possible, within the weight limitations of approximately 500 pounds for the system to adjust the vehicle for neutral buoyancy throughout its operating depth range. The craft also has an air system for blowing the main ballast tanks on the surface to provide freeboard and surface stability.

Instruments and Equipment

The instrumentation and equipment aboard ALVIN is used for the control and navigation of the vehicle and for scientific observations.

The control and navigation instruments are the gyro compass and gyro repeater, a magnetic compass, battery voltmeters, ammeters and



8.4

CROSS SECTION

DSRV ALVIN underway at normal surfaced condition
in Great Harbor, Woods Hole.

8-5

ground detector, indicators for depth, speed, list, trim and variable ballast, and a doppler navigation system. An atmosphere analyzing system with CO^2 and O^2 monitors, and pressure, temperature and humidity indicators is also installed.

An up and down-looking echo sounder is installed to give both height above the bottom and depth below the surface, while a scanning sonar set and a closed circuit TV system will be used in addition to the viewing windows. Lights are necessary at depths more than a few hundred feet depending upon water clarity. A sonar telephone system will provide voice or code communication with the mother ship for a range of five or six miles. A marine band radio telephone is available for use on the surface.

Scientific equipment aboard ALVIN on any particular dive will depend, of course, on the particular interests of the scientist using the vehicle. The vehicle is designed to be versatile with respect to the weight, space and power requirements of the portable scientific equipment so that the requirements of scientists in different disciplines can be met. Some scientific equipment will remain on the vehicle most of the time. These are a remotely controlled mechanical arm and associatd sample trays or jars, a precision graphic recorder for the echo sounder system, underwater cameras and associated strobe and incandescent lights, tape recorders, a precise frequency source for conversion from direct current to 60 and 400 cycle alternating electrical power, and movie and still cameras.

Support Equipment

ALVIN has been designed to require a minimum of assistance from large vessels. It will require a mother vessel, however, to lift it out of the water and to provide facilities for charging the batteries and air flasks, for replenishment of the life support system, and for long range communications. A catamaran barge is being built for this purpose, utilizing two Navy surplus floats, each 96 feet long and displacing 80 tons. The barge will have a platform which can be raised to lift the vehicle from the water, and sufficient deck space will be available to mount several portable vans. One of these vans will house diesel generator sets, electrical switchboards and air compressors. A second van is a machine shop equipped with a lathe, drill press, grinder, welder

and miscellaneous tools, as well as spare parts. A third van is an electrical and electronics repair and test shop. This van will also be used as a dark room and as the communications center. With these three vans, the catamaran will not have to rely on a large research vessel and can be towed to the operating area by a tug.

Safety Provisions

ALVIN is designed with certain features which permit emergency means of returning the occupants safely to the surface in the event of accident or malfunction. Each of the three batteries can be dropped to reduce the weight of the vehicle. The trim system mercury may be dumped through explosive valves. The mechanical arm can be dropped at the shoulder if it should become hopelessly entangled, and as a last resort, the pressure sphere itself can be mechanically disconnected from the rest of the vehicle. It is positively buoyant and will therefore float to the surface.

In case a fire in the sphere produces noxious fumes, or for escape in relatively shallow water, self-contained underwater breathing apparatus (SCUBA) is carried for each occupant. Chemical fire extinguishers are also carried.

Testing Program

All of the components which will be subjected to sea pressure have been tested in pressure tanks to well below the design operating depth of 6,000 feet (2,750 pounds per square inch). These include the pressure sphere complete with windows, electrical penetrators, hatch, release mechanism, etc.; the aluminum spheres required for additional buoyancy and for the variable ballast system; the syntactic plastic buoyancy material required for additional lift; and other containers subject to sea pressure.

All of the electrical motors, batteries, switches, pumps, hydraulic motors, and valves, are oil compensated to ambient sea pressure and have been operated in a test tank at 5,000 psi to insure their reliable operation prior to installation in the vehicle. A thorough check of all of the installed systems will be made both before and during initial sea trials, and an extensive operator training period in shallow water is planned prior to testing the craft to the design depth of 6,000 feet.

8.7

WOODS HOLE OCEANOGRAPHIC INSTITUTION 1930

The Woods Hole Oceanographic Institution was established in 1930 with the aid of grants from the Rockefeller Foundation and the Carnegie Corporation. The need for such an organization had been emphasized by a study sponsored by the National Academy of Sciences.

With a research staff of more than 100 and a large supporting group of technicians, seamen, administrators and office force, the Institution is engaged in a wide variety of oceanographic studies covering the basic disciplines of physics, chemistry, biology, meteorology, and geology.

Although its beginnings were modest, the Institution is today the largest private employer on Cape Cod and has established a world-wide scientific reputation. There are about 500 year-round employees, plus another 150 or so additional summer employees and students. Total operating expenses for 1963 amounted to more than 8.5 million dollars.

Over the years, although the size and influence of the Institution has increased considerably, the work pursued by its staff has concentrated on the complex but single objective of learning more about the world's oceans. Basic research, and education leading to more basic research—these are the principal and vital functions of this privately endowed, non-profit organization.

For more information about the Institution, its work and facilities, write or call the Public Affairs Office, Woods Hole Oceanographic Institution.

1 Dec. 1964

8.1

DEEP SUBMERGENCE RESEARCH VEHICLE

ALVIN

The Woods Hole Oceanographic Institution
Woods Hole, Mass.

ALVIN is the culmination of the efforts of many persons — the research scientists who insisted that they be able to examine by direct observation the depths of the seas, the engineers and the technicians whose skills have made its construction possible, and those in the Office of Naval Research who are determined that the United States Navy shall be better able to defend our country through greater knowledge of the oceans.

Paul M. Fye
Director

8.2

ALVIN

ALVIN is a deep diving research vehicle designed specifically for oceanographic research. Its existence marks the successful fulfilment of untiring efforts on the part of many people in research laboratories, industry and the Federal Government, to provide marine scientists with a means of descending safely into the oceanic environment to view first hand the objects they have been studying from afar. The need for a vehicle of this type has been recognized by the scientists of Woods Hole Oceanographic Institution and other marine laboratories for some time. Funds and inspiration for its construction were provided by the Office of Naval Research. The Bureau of Ships of the U. S. Navy assisted in the preparation of performance specifications for its design and construction, and the Applied Sciences Division of Litton Industries (formerly the Electronics Division of General Mills, Inc.) designed and built the vehicle.

Major Features

The vehicle is 22 feet long, has an 8-foot beam, displaces 13 long tons, and has a draft of 7½ feet in 'surfaced' condition. It is designed to have a top speed of up to 4 knots, a cruising speed of 2.0 knots and a range submerged of 15 - 20 miles. Its design operating depth is 6,000 feet with a safety factor of more than 1.8. The 7-foot diameter pressure sphere is made of high strength steel, 1.33 inches thick. There is room in the sphere for a pilot and one or two observers, together with instrumentation and life-support equipment which will provide an endurance of twenty-four hours or more. Four viewing ports permit the pilot and observer to see ahead of and beneath the vehicle. The only openings in the hull are the hatch and an emergency sphere release. All other connections between the inside and outside of the sphere are electrical, with the wires passing through specially designed fittings. The power for the vehicle comes from three banks of lead-acid batteries located in packages which may be dropped in an emergency.

The vessel is propelled by three propellers controlled by a "joy stick" from inside the sphere. There is a small lift propeller on each side which can be rotated so as to direct its thrust up or down, ahead or astern. A large propeller is located at the stern. The stern propeller

can be turned from side-to-side to steer the vehicle in the same manner that an outboard motor is turned to steer a conventional small boat. The two lift propellers are separately reversible to provide increased maneuverability; the vehicle can turn on its own axis by reversing one and going ahead on the other. All the propellers are driven by reversible hydraulic motors powered by hydraulic pumps which are driven by electric motors encased in oil. All these components are located outside the pressure sphere.

To control fore and aft angles of the vehicle, a mercury trim system is installed. This consists of two trim tanks, one located near the bow and the other in the stern. These tanks are half filled with mercury and half with oil. The tops and bottoms of the two tanks are connected with piping so that as oil is pumped from the top of one tank to the top of the other, mercury is forced from the bottom of that tank into the bottom of the first. Thus, fore and aft trim angles up to about 30° are possible.

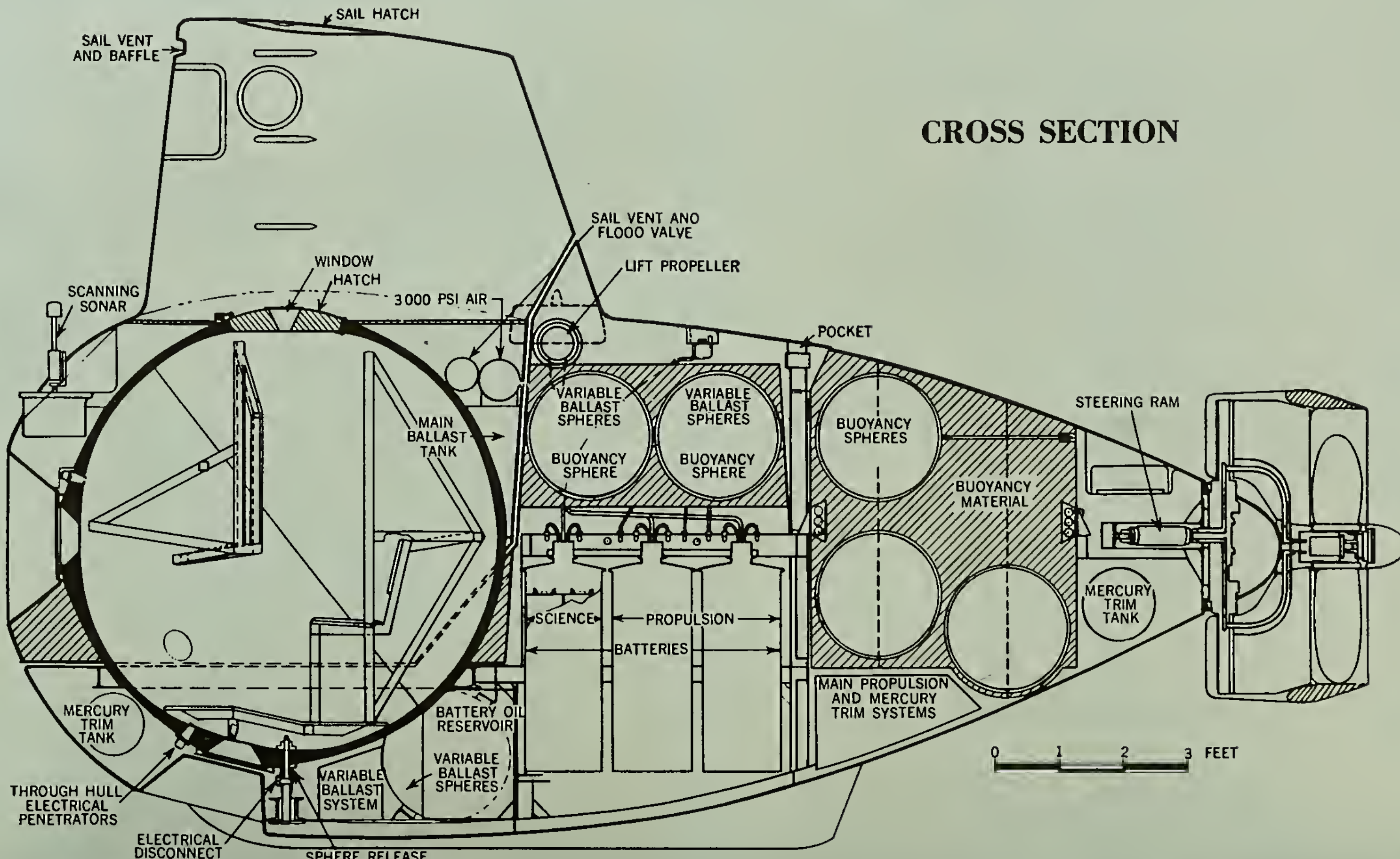
To compensate for differences in the weight of personnel and instruments carried and for changes in the density of sea water, a variable ballast system is included in the vehicle. This system utilizes inter-connected pressure-proof aluminum spheres and collapsible rubber bags which are partially filled with oil. As oil is pumped from the spheres into the rubber bags, the amount of sea water actually displaced by the vehicle is increased (thus increasing the buoyancy) while the weight of the vehicle remains the same. The effect is to make the vehicle "lighter." When oil is pumped from the collapsible bags into the spheres, the vessel becomes heavier. It is therefore possible, within the weight limitations of approximately 500 pounds for the system to adjust the vehicle for neutral buoyancy throughout its operating depth range. The craft also has an air system for blowing the main ballast tanks on the surface to provide freeboard and surface stability.

Instruments and Equipment

The instrumentation and equipment aboard ALVIN is used for the control and navigation of the vehicle and for scientific observations.

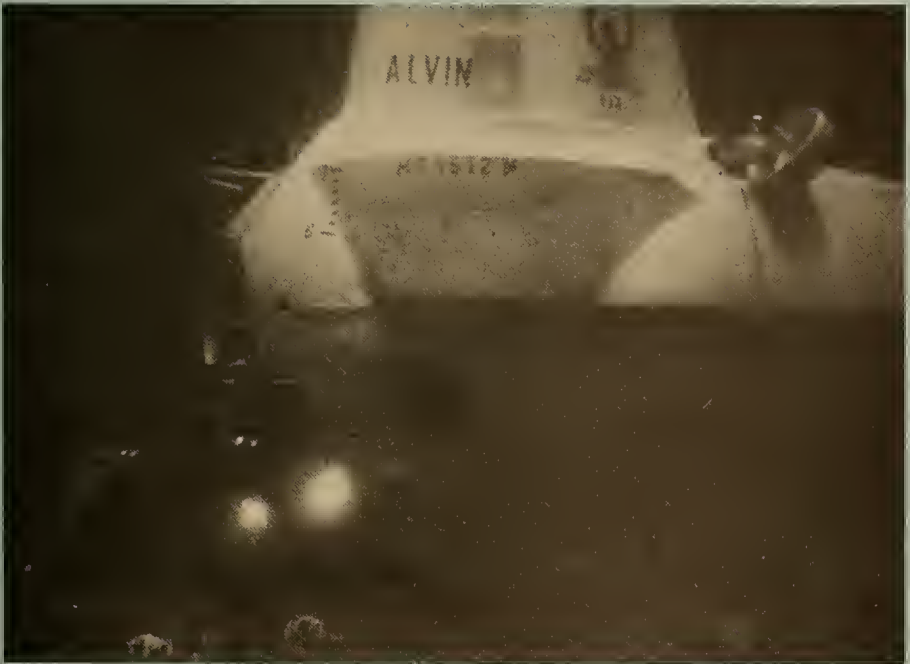
The control and navigation instruments are the gyro compass and gyro repeater, a magnetic compass, battery voltmeters, ammeters and

CROSS SECTION



8.5

ALVIN approaching CATAMARAN for recovery aboard following a deep dive



ALVIN in shallow water testing mechanical arm

ground detector, indicators for depth, speed, list, trim and variable ballast. An atmosphere analyzing system with CO^2 and O^2 monitors, and pressure, temperature and humidity indicators is also installed.

An up and down-looking echo sounder is installed to give both height above the bottom and depth below the surface, while a scanning sonar set and a closed circuit TV system will be used in addition to the viewing windows. Lights are necessary at depths more than a few hundred feet depending upon water clarity. A sonar telephone system will provide voice or code communication with the mother ship for a range of five or six miles. A marine band radio telephone is available for use on the surface.

Scientific equipment aboard ALVIN on any particular dive will depend, of course, on the particular interests of the scientist using the vehicle. The vehicle is designed to be versatile with respect to the weight, space and power requirements of the portable scientific equipment so that the needs of scientists in different disciplines can be met. Some scientific equipment will remain on the vehicle most of the time. These are a remotely controlled mechanical arm and associated sample trays or jars, an echo sounder system, underwater cameras and associated strobe and incandescent lights, tape recorders, a precise frequency source for conversion from direct current to 60 and 400 cycle alternating electrical power, and movie and still cameras.

Support Equipment

ALVIN has been designed to require a minimum of assistance from large vessels. It has its own mother vessel, however, to lift it out of the water and to provide facilities for charging the batteries and air flasks, for replenishment of the life support system, and for long range communications. A catamaran (DSRVT-1) has been built for this purpose, utilizing two Navy surplus floats, each 96 feet long and displacing 80 tons. The catamaran has a platform which can be raised to lift the vehicle from the water, and sufficient deck space is available to mount several portable vans. One van is a machine shop equipped with a lathe, drill press, grinder, welder and miscellaneous tools, as well as spare parts. Another van is an electrical and electronics repair and

test shop. With these vans, and its own facilities the catamaran does not have to rely on a large research vessel and can be towed to the operating area by a tug.

Safety Provisions

ALVIN is designed with certain features which permit emergency means of returning the occupants safely to the surface in the event of accident or malfunction. Each of the three batteries can be dropped to reduce the weight of the vehicle. The trim system mercury may be dumped through explosive valves. The mechanical arm can be dropped at the shoulder if it should become hopelessly entangled, and as a last resort, the pressure sphere itself can be mechanically disconnected from the rest of the vehicle. It is positively buoyant and will therefore float to the surface.

In case a fire in the sphere produces noxious fumes, or for escape in relatively shallow water, self-contained underwater breathing apparatus (SCUBA) is carried for each occupant. Chemical fire extinguishers are also carried.

Alvin's Mission

During the summer of 1965, ALVIN completed several dives to her design depth of 6,000 feet. These dives were made in the Tongue of the Ocean, a deep canyon in the Bahamas, and in waters near the island of Bermuda. Prior to these dives, the submarine had been lowered, unmanned, to a depth of 7,500 feet. With the successful accomplishment of these dives, ALVIN's year-long program of testing came to an end and the submarine was declared operational.

Now, for the first time, scientists are able to go into the ocean to depths of 6,000 feet. No longer need they rely on underwater cameras, coring equipment, trawls or dredges to do their sampling for them. They can view the oceanic environment themselves and selectively pick the samples of rock, sediment or marine life needed for their own particular project or study. Science has a new tool with which to prosecute a more rewarding study of the oceans.

2,8

The Woods Hole Oceanographic Institution was established in 1930 with the aid of grants from the Rockefeller Foundation and the Carnegie Corporation. The need for such an organization had been emphasized by a study sponsored by the National Academy of Sciences.

With a research staff of more than 100 and a large supporting group of technicians, seamen, administrators and office force, the Institution is engaged in a wide variety of oceanographic studies covering the basic disciplines of physics, chemistry, biology, meteorology, and geology.

Although its beginnings were modest, the Institution is today the largest private employer on Cape Cod and has established a world-wide scientific reputation. There are about 500 year-round employees, plus another 150 or so additional summer employees and students. Total operating expenses for 1964 amounted to more than 8.8 million dollars.

Over the years, although the size and influence of the Institution has increased considerably, the work pursued by its staff has concentrated on the complex but single objective of learning more about the world's oceans. Basic research, and education leading to more basic research—these are the principal and vital functions of this privately endowed, non-profit organization.

For more information about the Institution, its work and facilities, write or call the Public Affairs Office, Woods Hole Oceanographic Institution.

1 Dec. 1965

2. Notebook: Lower Cape Cod Town, Area Keith Coordinators; Registered voters 1966-1970; Republican Town Committees; Contributors; Town Monographs. 112 pages.
3. Notebook: Islands; Dukes and Nantucket County percentages voting in 1958 & 1960 elections; Keith votes, Area Coordinators; Town Monographs. 53ppages

WHOI Alvin. 1966 (1 folder)
1 Congressional Record-Senate, May 17, 1966 "The Submarine "Alvin", Mr. Mondale. 1 page
2. ~~1~~ Letter, April 1, 1966 (copy) Hastings Keith to Dr. Allyn Vine, Woods Hole, MA. Re: photograph taken In Washington, D.C. 1 page See Photographs 5.1
3. 2.Congressional Record-Appendix March 30, 1966 A1795 "Alvin" Is Making History, Extension of Remarks of Hon. Hastings Keith, March 29, 1966 1 page. 2 pages
~~3 Extension of Remarks of Hon. Hastings Keith in the House of Representatives, March 29, 1966 2 pages~~
4 Notes on conversation with Dr. Paul Fye, Woods Hole Oceanographic Institution re: Alvin 1 page 5
5 Cape Cod Standard Times, March 24, 1966 "The Alvin" 1 page
6 .Washington Post, March 18, 1966 "Sub Finds H-Bomb Off Spain" 2 pages
7 .Cape Cod Standard Times July 29, 1966 "Alvin Readied For Deep Dives off Bermuda Coast"
8 Publication:" Deep Submergence Research Vehicle: Alvin" by Woods Hole Oceanographic Institution. Dec. 1964 8 pages. Dec 1965 8 pages
9 Publication "Deep Submergence Research Vehicle: Alvin" by Woods Hole Oceanographic Institution. Dec. 1965 8 pages.
10. Geo Marine Technology Vol. 2, No. 5 February 1966 "Ten Months with Alvin" by James W. Mavor,Jr. Pages 8-18
11. Reprint from Naval Research Reviews "Alvin's World" by Hon. James H. Wakelin, Jr. 10 pages.

GEO MARINE TECHNOLOGY

Volume 2, Number 2
February 1966

CONTENTS

EDITORIAL

ENGINEERING REFERENCE FILE

NOTE!

This Running Wire Log is supplied for your use and convenience. By faithfully keeping such a log and centrally pooling the information thus recorded, we hope to learn more about the mechanisms of corrosion and failure of the wire ropes we place in the ocean.

Periodically, we will disseminate the information we have pooled among both the users and the manufacturers of wire ropes. This should aid the development of more reliable inspection and maintenance criteria as well as superior ropes at less cost.

Please send copies of the completed logs or data summaries to:

For additional copies of this form free of charge, address:

The Editor, Geo-Marine Technology
1074 National Press Building
Washington, D. C. 20006 U.S.

For the reasoning behind this wire log, see "Hydro-Wire" GMT Oct/Nov '65.

RUNNING WIRE LOG

SHIP ____________ WIRE ____________ WINCH ____________

CRUISE ____________ CH. SCIENTIST ____________ LAB ____________

Sta. no.	Date	Time to lower	Time to raise	Speed lowering	Speed raising	Meters out	Maximum tension	Wire condition	Sea state	Type of Cast Remarks	Oper. initials

WHOI 10-2

GEO MARINE TECHNOLOGY

Volume 2, Number 2—February 1966

Photo Credits: Cover, Wm. H. Amos; U.S. Navy, 5; National Science Foundation, 6; C. R. Stoertz, 7; David M. Owen—WHOI, 8-17; U.S. Weather Bureau, 19, 20; Reynolds Sub. Service, 25; Lockheed Shipbuilding, 28; D. W. Bourne—WHOI, 29.

General Manager, Nellie F. Hull
Advertising Manager, Keith R. Belch

GEO-MARINE TECHNOLOGY is published 10 times a year by INTEL, Inc., 1075 National Press Bldg., Washington, D.C.—20004. Tel.: Area Code 202, 638-5356. Cable: INTELINC. Printed and mailed at Baltimore, Md., by Port City Press, Inc. Circulation: over 7,500. Subscription Rates: Qualified Domestic, $5/yr.; $8/2 yrs. Unqualified Domestic: $12/yr. Qualified Foreign: $8/yr.; $14/2 yrs. Unqualified Foreign: $15/yr.

By the Mark

LOST H-BOMB AND THE SOS

Considering how unexpected was the loss of a thermonuclear device in the waters of the Mediterranean off the southeast coast of Spain, the dispatch and efficiency with which the U.S. Navy -- specifically Dr. John Craven and the Deep Submergence Systems Project -- pulled together all available and appropriate U. S. undersea search and salvage equipment (see P. 25, this issue) can only be commended. However, in the beginning there was some pretty frantic and time-consuming running around -- not so much to determine what was in existence as to ascertain what was available NOW, where it was, and how soon it could be working on station. Everything from DR/V's to "boomerang" corers were pulled off current jobs and rushed by means of the fastest transport available to the Mediterranean. There was not even time for proper contracts to be drawn up; hundreds of thousands of dollars worth of services were contracted for verbally, sometimes by phone.

By the Mark for March 1965 proposed the concept of SOS -- Scientists On Stand-by, "men and equipment identified and located throughout the world and eager to move at a moment's notice to any part of the globe where a major natural event occurs." By "natural event" we were talking of such things as the birth of a new island, like Surtsey (GMT, February '65), the "Good Friday" earthquake in Alaska, the occurrence of El Niño, and other similar natural phenomena. However, the concept is equally as applicable to certain man-induced events -- such as the loss of Thresher, the collapse some years back of the Texas Tower, the recent sinking of the offshore drilling platform Sea Gem, and now the loss in comparatively deep water of an H-bomb. In the ocean, at least, the problems and requirements of search, location, examination and possibly recovery are quite similar to those of the acquisition of scientific data. In fact, in many instances both scientists and scientific equipment are required as active participants; only the mission is different.

The advantage in the case of the H-bomb search of an SOS system in being would have been manifold. One duty of such an organization would be the maintenance of a complete up-to-date file of the location, current activities and readiness status of participating equipment and services throughout the world. Also on file would be listed complete specifications and capabilities (in the case of vehicles), existing on-board equipment, and the capabilities for adding additional gear. Ideally, this would be a computer file so that retrieval of pertinent data on the required capabilities would take no more than a few minutes. Similarly, the contractual arrangements for the use of both men and equipment could have been fully worked out in advance -- thus both adding to the capability for fast response and leaving much less to future (after the fact) dispute and negotiation. Further, our resources would be those of the whole Free World (at least) rather than only those we (the U.S.) have in being. We are thinking of the British National Institute of Oceanography's remarkable high-resolution side-looking sonar, France's Spontaneous Potential Detector, and of Cousteau's diving saucer in the present instance.

The impetus for SOS should come from the White House, but, though it has been suggested to Presidential science advisor Dr. Donald F. Hornig, he seems to have done nothing about it. Administration and maintenance of an international SOS headquarters falls naturally within the purview of the National Academy of Sciences. If the White House is not inclined to bestir itself, NAS itself can examine the pro's and con's and feasibility of SOS and make appropriate recommendations to both the President and the Congress. Man can predict neither the time nor the form of the natural cataclysms that periodically beset this planet or of the accidents that he himself produces and which press upon him with great urgency. But he can -- in much better measure than now -- be prepared for them when they do occur.

Seabrook Hull

GEO MARINE TECHNOLOGY

February 1966 — Vol. 2, No. 2

Edited by Robert M. Snyder

«За бездефектную работу»

This sign is predominantly posted throughout about 2,000 Russian plants. This fact is reassuring, for it indicates that they aren't infallible either. Literally translated, it says: "Work Without Defect." We call it "Zero Defects."

- - - Shipyard Log, Pearl Harbor Naval Shipyard

FROM OUR READERS AND EDITORS IN THE FIELD

Possible Answer to Marine Railway Corrosion

The peculiar corrosion of rails in a marine railway, reported from Mt. Desert, Maine in your October/November 1965 issue, intrigued me for many reasons. These included the description of what happened, the nature and effectiveness of of the remedy, and the suggested mechanism of the damage. The only situation that I can visualize that would tie into what was reported is the following:

Stray Electrical Current

The rails had somehow become part of the path of a stray electrical current so that each acted as a dipole receiving current at its upper end and discharging current at its lower end to the next rail down the line. The bottom rail discharging current into the sea should have continued to suffer accelerated corrosion.

Technical Discussion

The technical objections to what was stated in the published paragraph include:

(1) The salt water impregnated wood would supplement rather than complement the sea water as an ionic conductor. The necessary electronic conductor was provided by the metal of the rails, to enable either temperature differential or, more likely, oxygen concentration cells, to exert any effects. Neither effect would be altered substantially by bonding the rails, beyond providing some oxygen cell cathodic protection of the rails in the tidal zone areas at the expense of accelerated corrosion of rails submerged all, or most, of the time.

(2) Research reported by H. H. Uhlig and O. F. Noss, Jr., in a paper before NACE (CORROSION, Vol. 6, 1950, p. 140) indicated that effects of temperature on corrosion potentials in salt water were overshadowed by effects of temperature on oxygen solubility. In the absence of oxygen there was no temperature effect. In the presence of oxygen the iron in the hot solution containing this oxygen became anodic to the extent of 24 millivolts for a differential of 100°C.

(3) Without electronic conductor bonding between adjacent rails, neither could affect the corrosion of the other. Consequently, bonding the rails should have accelerated rather than retarded corrosion due to differential temperature or differential aeration effects.

(4) The only mechanism that would have been eliminated by bonding the rails would be stray currents running from the shore end of the rails to the sea, as previously suggested. The best indication of the reality of this mechanism would be continued accelerated corrosion of the ends of the last rails where they enter the water. This should be easy to check.

- - - Francis L. LaQue
International Nickel Co.

The Singing Fish Of Batticaloa Lagoon

For many years in the vicinity of the Lady Manning Bridge spanning Batticaloa Lagoon, Ceylon, night strollers and passers-by have heard a strange and haunting music emanating from the Lagoon's waters. The sounds of this music have been recorded from above the water's surface and even broadcast over local radio stations. While it is now common knowledge that the creatures of the sea produce a great variety of sounds, the origin of these particular notes have long puzzled local residents. The notes of this eerie night music range from deep base tones and croaks to (once falsely attributed to frogs which don't frequent salt water) "single notes of rather medium pitch coming as from a harp, or from plucking violin strings when tuning." These sounds have been attributed, variously, to "singing telephone wires" and the ocean's currents passing the mouths of a species of shell known to exist in the lagoon. More recently, it has been quite firmly established that the sounds are made by fishes.

A Species Of Croaker

Japanese fisheries experts visiting Ceylon attribute the sounds to a variety of fish called "guchi" by the Japanese, "White Croaker" by the English and with the Latin names of argyrosomus argentatus, seiana schlefeli or Nebea argentata. Explain the Japanese: "The singing notes are produced by friction when the fins move about slapping the body. A second possibility is that the sweet notes are caused by vibrations when water go through some bones, such as the nasal bones, during breathing."

To Protect A "Mike" Use A Football

Local Jesuit priests have recorded the sounds using an underwater microphone. They note that "there are clearly four different notes or sounds, and a fifth may be discerned with close attention. A sixth note, higher on the scale than the ones recorded, was heard but not recorded because of adjustments to cut down on vibrations caused by one very deep base every time it was heard." In one instance, at least, the priests made their underwater microphone "by carefully working a regular microphone into the air chamber of a football, inflating the air chamber and dropping it into the Lagoon."

- - - S. V. O. Somanader
Kalkudah, E. P., Ceylon

Don't Scrape It Just Hose It

Recently we've tried hydro-blasting as a more efficient, less troublesome, less expensive way of cleaning ships' hulls in drydock. The objective of hydro-blast is to remove sea growth, light rust, loose paint and, in general, prepare surfaces for recoating by blasting with water under high pressure. By using this technique on the submarine <u>Tang</u>, we saved $7,000 on her overhaul bill. The unit we have on trial at Pearl Harbor Naval Shipyard is manufactured by American Powerstage Company. It is the Triplex Power Pump, TD-50 -- with a capacity working pressure of 5,000 psi. It removed all sea growth, loose paint and rust but did not damage the intact film.

Upon completion of blasting, all bare surfaces were primed with pretreatment wash primer F-117 to prevent surface corrosion. The intact paint film was examined, and there were no pinhole penetrations, such as would result from abrasive blasting. None of the protective measures normally required for sandblasting were necessary. There were no abrasive hazards to machinery or personnel, no clean-up of the dock basin to remove sand, and no damage to dock pumps from residual sand. The underwater hull surface covered 18,000 sq. ft. By eliminating the use of abrasives, protective measures, sand removal, etc., the cost of hydro-blasting was $.51 as compared to $.70 sq. ft. for abrasive blasting.

The full potential of this unit has yet to be evaluated, such as its use in bilge and interior tank and compartment blasting. In October 1965, this unit was shipped to Ship Repair Facility, Yokosuka, Japan, to remove Styrafoam from the USS Frank Knox's machinery spaces. The removal of foam was fairly easy. In fact, it could be accomplished with less pressure -- about 2,000-to-3,000 psi.

While elimination of sandblasting is not anticipated, we should be able to cut the use of sand in half. And, we should certainly consider the use of detergent

sprays and extend the use of the hydro-blast technique to engine rooms, bilges, tanks, etc.

--- Harland Morley, Master Mechanic
Service Group, Pearl Harbor Naval Shipyard

FROM THE STAFF

"Electronic" Sponge Classified SECRET

"It looks", said a puzzled Smithsonian biologist, "like an antenna with thermisters sticking out all over." He had just seen the above photograph, taken at Lat. 50° 07' S, Long. 105° 03' W at a depth of 2,120 fathoms on a scientific cruise of the National Science Foundation's antarctic research vessel, Eltanin. The U.S. Navy apparently had the same opinion, as the photo was not released immediately for publication. "Maybe the Russians have gotten there first." The object was identified finally as a two-foot long deep-sea sponge. Photographed in antarctic waters at a depth of from two to three miles, the sponge is probably the genius Cladorhiza, described in 1888 by Agassiz in "Three Cruises of the U.S. Coast and Geodetic Survey Steamer Blake". He says, "Cladorhiza were not uncommon in the deeper dredgings of the Blake. They are sponges with a long stem ending in ramifying roots deeply sunk in the mud. The stem has nodes with four to six club-shaped appendages... They evidently often cover, like bushes, extensive tracts of the bottom." Photographs of Cladorhiza are rare, however, and the Navy was unwilling to throw in the sponge until its natural origin was established. This one, incidentally is surrounded by manganese nodules.

--- C. R. S.

Seismic "Fishing" In Cold Waters

Lamont's Air Gun Fish

Conducting research in Antarctic waters has problems of its own. We put a great deal of effort into the development of proper towing methods for the air gun fish used aboard the Eltanin, for Lamont's geophysical program. Improper towing had caused tangling in the air hose and towing wire. It is now being towed at 10 knots with no trouble. When the vessel is hove to on station the entire seismic system is pulled in, hydrophone array, air gun, and magnetometer. Both a sparker and an air gun are used -- the sparker gives weaker signals but has fewer towing problems. Various fluids were tried in the hydrophone eel -- seawater and fresh water froze, diesel oil was unsatisfactory, castor oil was not only expensive but hard to get in foreign ports. On Cruise 17 (Mar65-May 65) one of the women biologists suggested glycerine, which has been used satisfactorily ever since. Casing for the eel was originally made of PVC (poly-vinyl chloride tubing) but in temperatures below 7°C the plastic hardened and the unit lost sensitivity. Present eel is 2" ID neoprene tubing with 2-ply nylon reinforcement (BF Goodrich, Aerospace and Defense Products Div.) It costs almost 3 times as much (a total of $425.00 for 100' of neoprene as against $150.45 for PVC), but seems to have licked the problem. Another problem solved with ingenuity was condensation inside the air compressor. At Antarctic temperatures the moisture froze. Seems one of the boys (we're using no names) had a bottle of gin aboard which he sacrificed for the machine -- no more freezing. Other shipboard problems were caused by debris tossed overboard. In one case the equipment was hauled in because of a poor signal and a two-foot wire was found wrapped around the sensor. Or by other oceanic problems -- sharks take a bite out of the eel or magnetometer occasionally. It's not at all unusual to find evidence of tooth marks in the eel or even teeth themselves. As recounted by:

--- Anonymous

A Good "Glup" For Ocean Service

For what it's worth, while we were wandering about ONR's monster buoy last fall, we noted the extensive use of a potting compound which seems to work very well in oceanographic service, particularly perhaps in a prototype system where adjustments and fixes require periodic depackaging. This is a two-component mix known by the designation "EC-1293" and manufactured by 3-M Co. At or near the surface, at least, it appears to be completely impervious to seawater intrusion and never gets completely hard. The two components are readily mixed on the spot and it is easily applied. One minor problem: If you get it on yourself or your clothes, it won't wash off; you've just got to wear it off! Also, don't

read more into this comment than is stated. This report is based on surface and near-surface application; we don't know anything about its performance at great depths. Check with 3-M, and if they don't know, test it out yourself.

- - - E. W. S. H.

For Shut-in Shutterbugs
Shooting The Briney Deep

Some of you who are diving for the first time in one of the nation's growing number of deep submersibles will undoubtedly be taking your cameras along, even though the craft may be equipped with external cameras of its own. On the basis of one dive (in Aluminaut) this editor has the following suggestions:

(1) Since the ports are in all probability made of lucite and since scratches (or any other notches) are high stress raisers, attach a sunshade to your camera and then line the leading edge of that sunshade with plastic electrician's tape. This gives you a soft surface that won't scratch the viewing port; it also prevents any stray light from entering the lens.

(2) Don't try to shoot through the port at an angle. As a starter, there is bound to be light reflected from the inner surface of the port, which will interfere with your picture; in fact, it might become the dominant image. Further, remember that before the light reaches your film it passes through, in turn, water, lucite, air, glass and air again. Keeping in mind the effects of refraction, the more you can keep the light normal to the various interfaces, the better off you'll be.

(3) Take a light meter with you. Held parallel to and close to the viewing port, it provides a reasonably reliable reading, though this editor prefers also to vary his exposure to either side of the indicated setting.

(4) Without some kind of "yardstick" for reference, it is quite difficult to judge size and distance looking through one of these ports. So, it's advisable to use as small an f.-stop as possible, in order to take advantage of the greatest depth of focus -- or margin of error. In all respects, a through-the-lens reflex is the best kind of camera to use.

- - - E. W. S. H.

New Lubricant For
Titanium and Stainless Steel

For those of you with a desire to use titanium and stainless steel parts in configurations where a lubricant is required, hail to a new and unique line of iodine lubricants that finally make it practical. In the past these materials have exhibited a notorious resistance to conventional lubricants. Titanium parts, for example, rubbing together or against a piece of steel seize of weld themselves to the other surface. Stainless steel is equally troublesome. The new line of iodine lubricants eliminate these problems and, in fact, produce coefficients of friction for both materials on the order of 75% lower than when conventional lubricants are used.

The lubricants work as follows: Iodine reacts with titanium and iron to form iodides. The crystal structure of both titanium diiodide and iron diiodide is layer-like, possessing planes of very low shear strength -- which easily slide in a lateral direction. This action reduces both friction and wear.

Since it is impractical to use pure iodine as a lubricant, it is used in the form of a "charge transfer complex with hydrocarbon compounds". These compounds can be used alone or as additives to conventional lubricants. In one test where hydrocarbon oil was used alone as a lubricant for sliding surfaces of 302 stainless steel, seizure occurred under a load of 2,500 psi. The addition of as little as 0.6% iodine to the same oil as a charge transfer complex increase the load-carrying capacity to 137,000 psi. The lubricants were developed by Robert S. Owens and Dr. Richard W. Roberts at General Electric Co.'s Research and Development Center, Schenectady, N. Y. for jet aircraft and spaceflight applications. However, with their high corrosion resistance, these materials are also leading candidates for deep ocean work -- where high loads are also found. The information for this item came from R. P. I.'s Rensselaer Review for the winter of '65.

- - - R. M. S.

the voice of experience

TEN MONTHS WITH ALVIN

a rundown of lessons, limitations, capabilities

By James W. Mavor, Jr.
Deep Submergency Research Vehicle Project
Woods Hole Oceanographic Institution

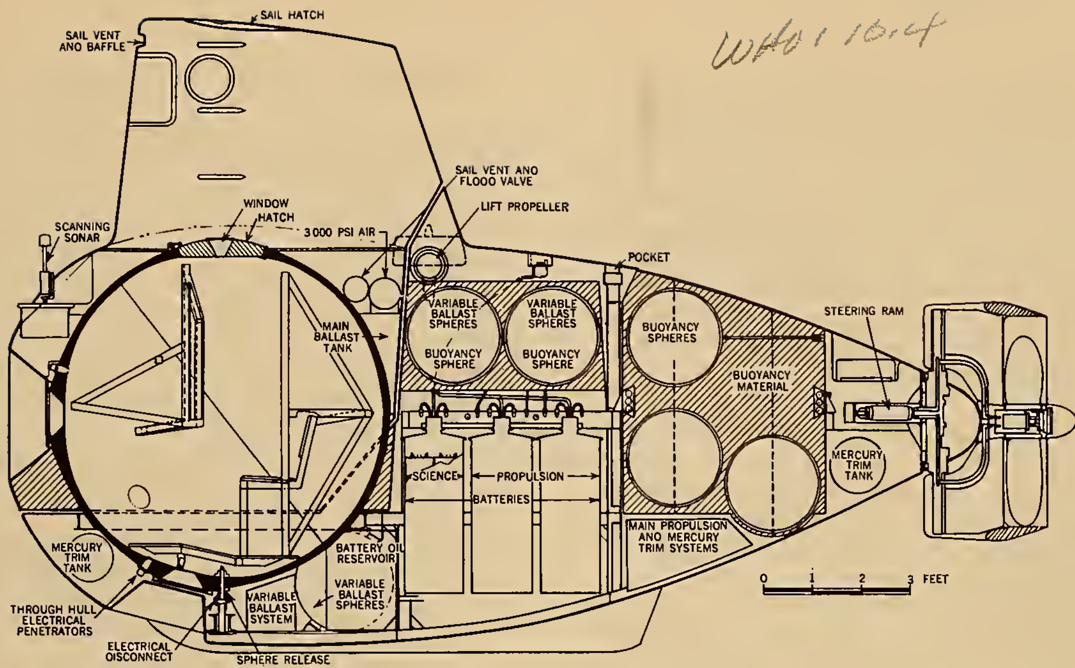
INTRODUCTION

Alvin, the first deep diving submarine, as contrasted with the vertical traveling bathyscaphe, has recently completed a 6-month period of shake-down operations during which the vehicle and her support equipment experienced the real ocean environment. This was preceded by a 4-month test period and a 6-month refit period. Such experience was not gained without dedication and personal risk on the part of the operating crew; some fifteen people are required to maintain operations at sea exclusive of the towboat crews (if required). Of course, malfunctioning equipment, inadequately designed equipment, bad weather, and sliding schedules, are to be found on such a cruise, as all seagoing oceanographers well know. These inconveniences are accepted because: 1) many new basic concepts are undergoing service experience; and 2) criteria of design adequacy are not known and cannot be known without design trial by sea. From this trial, which included 107 dives during a 16-month period, it is believed that Alvin, her support equipment and crew have emerged as a successful team capable of conducting dives and doing useful work to depths of 6,000 feet in the open ocean.

As is widely recognized, the deep submersible and her support equipment must be an integrated system. Such a design approach has not been carried through to date, largely due to lack of basic data or relevant sea experience. It is the intention of this paper to contribute to building just such a body of reference material. It covers some of the fruits of seagoing experience with Alvin and her support equipment which may be of value to engineers, both in their current related technical problems and in gaining financial support for the more sophisticated engineering procedures which should follow better definition of the problems.

EXPERIENCE WITH ALVIN

During the evolution of Alvin and her support equipment numerous procedures were formalized in a document known as the "Management Plan for Deep Sea Research Vehicles". This includes organization, responsibilities for personnel, operations, maintenance, alterations and major procurements, surface control equipment descriptions, emergency procedures and safety precautions, diving endurance, levels of criticality, daily maintenance routine and check list, inspection record, weekly maintenance routine, monthly maintenance routine, semi-annual maintenance routine, annual maintenance routine, engineering change



procedures, test specification form, test form, and requirements for acceptance of DSRVG material.

Five Levels of Criticality — In an experimental project, all of the above are subject to continuous revision in the light of experience. One item, levels of criticality, is singled out for discussion. Five levels of criticality were established for Alvin to help establish design, construction, and operation criteria and resolve conflicts. They are as follows:

I. Personnel (submarine only) -- Those systems or components which assure that occupants return to the surface alive.
II. Major Material -- Those systems or components, the malfunction of which would lead to loss of the afterbody or the unmanned submarine itself.
III. Use or Mission -- Those systems or components whose malfunction may abort a dive or delay operations.
IV. Efficiency or non-critical -- Any system or component associated with diving operations not in category I through III.
V. Others.

FAILURE CATEGORIES Such a list is important to assure proper emphasis on personnel safety within the ever-present cost limitations and the severe weight limitation imposed for craft of this type. It is also important in assessing the significance of a malfunction or failure during operations, when the decision must be made whether to abort a dive or not, and whether or not to initiate a dive when a known malfunction is present. It must be emphasized, however, that the significance of a system failure or malfunction can only be assessed with a full appreciation of operational procedures, maintenance procedures, and the submarine itself. In other words, only someone working constantly with Alvin is in a position to do this. The reader should not jump to the conclusion that a malfunction in Category I will necessarily endanger the personnel. In point of fact, during Alvin operations no malfunctions or failures have occurred which are considered to have significantly lowered personnel safety below the level existing with a fully operating vehicle. No Category I failure or malfunctions have occurred. In Category II a leak in a variable ballast rubber oil reservoir was discovered by routine operation and maintenance procedures and repaired before a dangerous situation existed. All other failures and malfunctions have been in Categories III, IV, and V.

CHANGING EMPHASIS In the early development and trials of Alvin, efficiency was not a major consideration, but now that operations have reached a more stable phase, the cost in time and overhead has made efficiency of importance. Time and money are now being spent on Categories III, IV and V rather than I and II, as was the case during design and construction. This, of course, is the normal history of an experimental or prototype project. It is hoped that the next generation of research vehicles (RFB's have been issued on two improved Alvins) will build on Alvin experience in this area.

QUOTATIONS TO BE ANSWERED A comprehensive account of the Alvin design and construction has not yet been published, and such is not the aim of this record -- though the task

WHOI 10.5

would be simpler if such an account were available to all readers. Failing this, a bibliography of reports and publications is appended, and it is assumed that readers are engineers and are familiar in a broad sense with the problems of this type of operation. The remainder of this paper will be devoted to a discussion of some of the characteristics and systems of Alvin and her mother vessel. In each case an attempt is made to answer three questions: (1) What criteria determined initial design? (2) How did it perform in test and/or in service? (3) What changes are recommended?

ITEMS NOT INCLUDED Notably, a discussion of instruments is omitted. Though they must be integrated into vehicle design and operations as stated previously, their details are, properly, material for a separate paper. These instruments would include: underwater telephone, scanning sonar, echo sounder, surface radio, tracking sonar, underwater lights, underwater television, underwater cameras, manipulator, Doppler navigator. Also omitted are a discussion of the detailed records of the pilots and observers and the very interesting narrative of day-by-day operations at sea. This author has merely in some cases drawn conclusions based on digests of these events.

ALVIN VEHICLE CHARACTERISTICS

LENGTH OVERALL 22 feet -- satisfactory.

SURFACE DISPLACEMENT-LIFTING WEIGHT 29,960 pounds -- Strict weight control was the major bound imposed on the design of Alvin. The original weight specification called for a weight of 22,400 lbs. As a result of successful operations with the catamaran mother ship, 29,960 lbs. is considered acceptable for handling with a reasonably small support craft.

SUBMERGED DISPLACEMENT 31,460 lbs. Displacement of faired envelope: about 40,000 lbs. The faired envelope displacement for resistance. The submerged resistance of Alvin has been measured by 1/16 and 1/4 scale model tests -- both somewhat crudely. Submerged speed versus power trials and static thrust versus power trials, as well as propulsion system internal tests, have been run, from which resistance has been deduced. All five methods have resulted in a drag coefficient based on wetted surface of $C_D = .028$ -- a substantially higher value than anticipated. In fact, it appears that the drag of a submarine having a length-diameter ratio of less than 3, as Alvin does is practically independent of shape. In a future design it is suggested that the exterior lines be among the last features delineated and drawn with primary attention to arrangement and access rather than drag, propulsion, and appearance.

RESERVE BUOYANCY ON SURFACE 1,500 lbs. Alvin has spent considerable time on the surface in sea conditions up to state 4. 1,500 lbs., or 5% of displacement is a satisfactory figure.

SCIENTIFIC PAYLOAD The design figure was 1,200 lbs. air weight, with 100 lbs. displacement. For administrative reasons the payload included much equipment which has since become mandatory operational equipment, and in the future designs, should be recognized as such. Such items of equipment as scanning sonar, underwater telephone, surface radio, up and down echo sounder with PGR, underwater lights and underwater television were considered scientific payload in the Alvin design. They are currently all considered mandatory items of basic operational equipment. Other navigation or communication equipment which may supplement these may well have to be integrated into the vehicle as operational equipment. Thus, Alvin's payload available for scientific instruments, in addition to those mentioned, is substantially less than 1,200 lbs. On the other hand, the use of syntactic foam for buoyancy has been so successful that compensating buoyancy can be attached to the exterior of Alvin without any detrimental effects other than some increased weight. This can be either temporary or permanent. In fact it is suggested that rather than using compensating lead in the small submarine, compensating buoyancy is a more positive concept.

STABILITY, LIST AND TRIM, AND DYNAMIC ATTITUDES Alvin currently operates with a surface transverse metacentric height of 7.5 inches and a submerged BG of 3.4 inches in normal load condition, which is defined as a real operating condition arrived at after shakedown trials from which only small departures have been made to date. Some emergency conditions have been calculated, and positive stability, both surfaced and submerged, is attained in all of them. The positive stability of the forebody alone has been verified by actual ejection at sea. Initial list due to loading or roll have not been problems. Trim is controlled by the mercury trim system (Fig. 1) and by the lift propellers. The mercury trim system was designed for ± 30° angle, but some 45° total range is obtained in practice because static stability is greater than anticipated. However, it appears that a static trim system may be redundant. In trying to simplify and lighten a vehicle design a trade off here is worth considering. An entirely dynamic trimming capability may be sufficient. Some hydrodynamic instability has been experienced at all speeds. This has required almost constant use of the rudder to maintain course. It may be correctable with stabilizing fins.

MANEUVERABILITY A geologist riding as observer in Alvin has put it simply "As we cruise over the bottom, I see a rock. I want to pick up that rock or I want to photograph or observe that rock more closely. Otherwise the submarine offers me no more than a towed sled." As a generality one might take exception, but nevertheless, the submarine must (1) be able to stop and change position and attitude in a current in a short distance without the observer losing sight of the rock; or (2) it must have a navigation system good enough to enable it to return to the rock after having lost sight of it. Alvin does well in the case of the first alternative, though if she overshoots, there are no rear

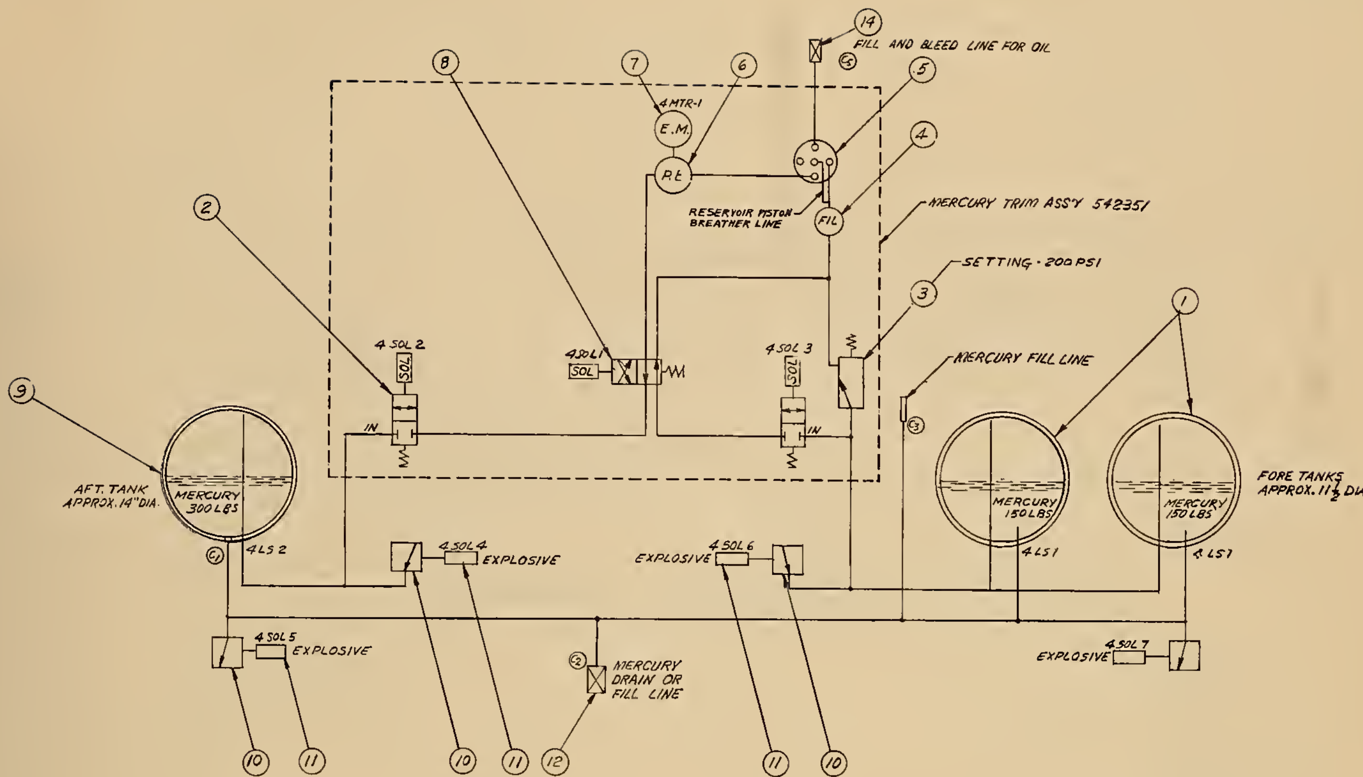


Figure 1 -- Alvin Mercury Trim System.

windows to maintain visual contact with the target. A navigation system is being developed using visual and sonar beacons, but this is by no means ready for use at depth.

SPEED AND RANGE 2-2.5 knots and 20 miles. These figures are less than the design specifications, due to high resistance, poorer battery performance than expected, and possibly a poorer propulsive coefficient than anticipated. So far the only requirement for higher speed seems to exist near the surface where currents are strong. It has been found that in an area of strong currents, such as Bermuda, it is difficult to reach a predetermined location on the bottom at 6,000 feet depth.

NUMBER OF PERSONS ABOARD <u>Alvin</u> was planned for one pilot and one observer. However, there is space for a second observer who, in fact, has been carried on several dives. The provision for the second observer is considered highly desirable, based on this experience. In addition to the availability of two more eyes, operation of the increasingly complex equipment carried in the sphere keeps two persons busy even now.

WEIGHT CONTROL Creeping heaviness of the DR/V due to modifications and additions is a disease of small submersibles -- as with every other craft afloat. The traditional approach to this problem has been to maintain a complete, accurate and up-to-date component weight list. This tedious process does not seem to be necessary except for the variable load. It has been found that weighing the DR/V in water is a simple, accurate procedure for discovering weight changes.

A L V I N O P E R A T I O N A L S Y S T E M S

PRESSURE HULL The pressure hull and its appurtenances -- hatch, windows, electrical lead-throughs and mechanical through-hull shaft -- were subject to a great deal of design attention and test. A number of reports have been written on these subjects. There has been no failure or leakage at any time. Analysis has shown the pressure hull to be stronger than necessary, and a substantial weight saving would be available by making the hull thinner. Experience with a 6 ft. 7-1/2 in. inside diameter hull has shown that an 8 ft. diameter would be a considerable improvement -- particularly in the case of a three-man crew. Increasing the size of the pressure hull appears, in this case, to be the most economical way of gaining the necessary increased buoyancy -- which has turned out to be an expensive item. The plexiglass windows, which were designed from the data of A. Piccard, have turned out to be conservative by full-scale test. Optical improvement is possible in future designs by using different shapes and thinner windows than the 3.5 inch thick 90 degree ports used with <u>Alvin</u>. A comprehensive full-scale window test program has been performed including such parameters as fit, crazing, chipping, creep. These tests were performed to 11,500 psi.

WHOI 10.7

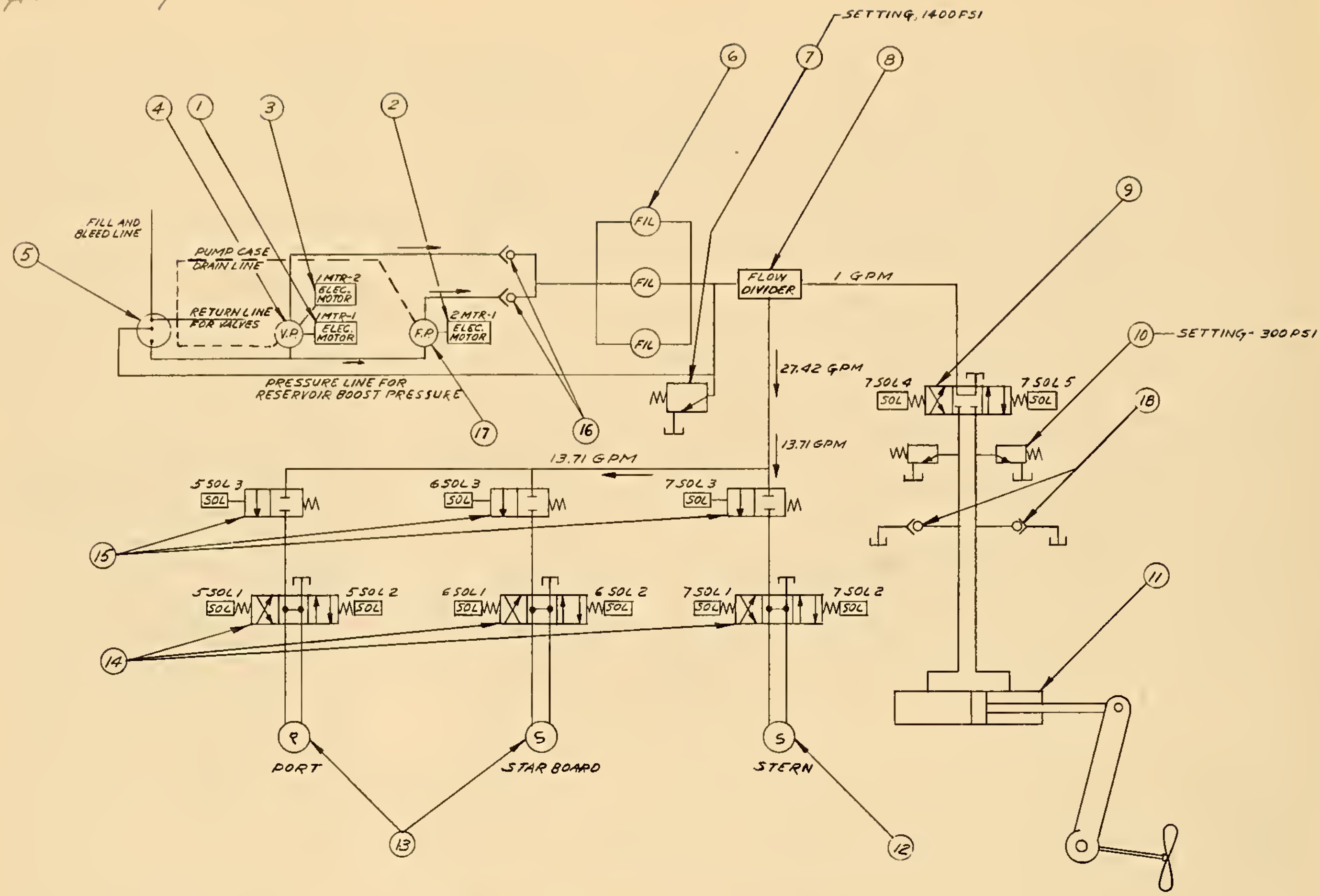


Figure 2 -- Alvin Main Propulsion System.

MAIN PROPULSION Unfortunately, insufficient data is available to fully analyze the propulsion of Alvin. However, as was mentioned previously, drag was found to be high, which reduces efficiency. Two interesting features of the Alvin propulsion are being followed up by model test and theory. (1) The hull efficiency with the large propeller on the axis of symmetry is believed to be as great as 150%, and (2) the very low loading of the large propeller, appears to make a design of propeller possible having an efficiency of up to 85%. The present stock propeller was selected because it was believed that some inefficiency could be tolerated, and initial cost was vital. The main propulsion plant is shown schematically in Fig. 2. Two 7.5 HP rated electric motors drive a variable and a fixed volume hydraulic pump, respectively. These, operating in parallel, are piped to the main hydraulic (orbit) motor in the hub of the propeller.

PROPOSED PROPULSION CHANGES It is quite evident that a large propeller on the axis astern is the most efficient cruising propulsion. This is an important part of any small submersible that is intended to have a substantial range, say 20 miles or more. For maneuvering, there are a number of reasonable choices. Alvin uses her horizontally rotating stern propeller with success as well as her lift propellers. However, ducted propellers fore and aft appear attractive. An arrangement is proposed consisting of a fixed stern propeller, with a rudder for fore and aft propulsion and cruising steering, while a vertical thruster amidships would be used for lift, and a horizontal thruster aft used for low speed maneuvering in the horizontal plane.

COMPONENT EFFICIENCIES The choice of hydraulic or electric power transmission required more study of component efficiencies than has been performed to date with Alvin. For the short endurance required of these small vehicles, propulsion system component weights are a substantial relative to battery weight. The author's best estimates of Alvin component efficiencies are as follows. (Please note that up to the present time it has not been feasible to obtain direct measurement of individual component efficiencies under actual environmental conditions.)

electric motor	67%
hydraulic pump	75%
steering bypass	92%
hydraulic transmission	90%
hydraulic motor	64%
propeller	50%
hull	160%
OVERALL	21% = EHP/Propulsion Bus Power

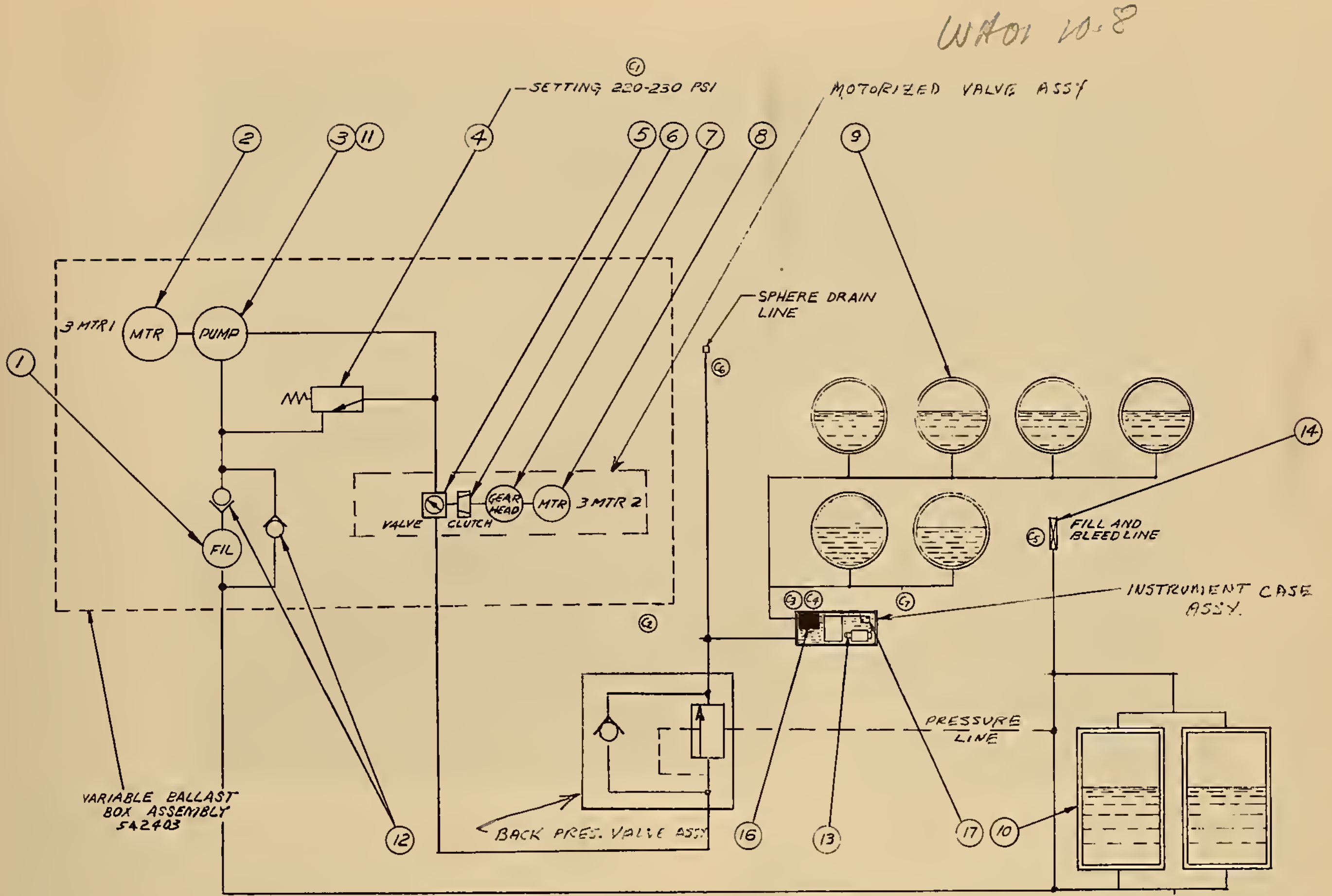


Figure 3 -- Alvin Variable Buoyancy System.

An all-electric drive would have a higher over-all efficiency, but for comparable performance -- including steering and low speed continuous speed control -- would be substantially heavier than the hydraulic system.

VARIABLE BALLAST SYSTEM Fig. 3 shows schematically the unique method of buoyancy control. Oil is pumped from six aluminum spheres to two rubber bags and back again to increase or decrease displacement, respectively. When they are empty the air pressure within the spheres is atmospheric. The rubber bags are evacuated before filling the system with oil. When oil is pumped into the spheres the air pressure increases to a working limit of about 250 psi, at which point a relief valve prevents further buildup. The indication of variable ballast condition is the pressure of the oil between the pump and the spheres, or air pressure plus static head of oil. In early operations a direct pressure indication was used which was very insensitive at low pressures. A circuit was then devised which gave an output that varied linearly with the weight of oil in the spheres. The indicator dial was then labeled pounds of buoyancy available, which is equal to the sea water displacement of the oil remaining in the spheres. Sensitivity of the readout was +/- 25 lbs. During the deep dives of 6,000 feet the effect of temperature was observed. As the sea temperature decreases with increasing depth, the pressure of the air in the spheres decreases causing the indicator to show less oil in the spheres than actually exists; or if pumping or flooding of the oil takes place during descent, the operator gets the false impression that the vehicle is becoming heavier and variable ballast compensation is taking place. This error is predicted to be 80 lbs. in 6,000 ft, though some local variation is to be expected. An accurate knowledge of this effect is required to assess the actual change of displacement of the vehicle due to compressibility of the vehicle and the change of seawater density due to pressure and temperature. The variable ballast system has behaved satisfactorily in general. The rubber bags have leaked and are prone to fatigue damage, so that an improvement would be the elimination of the oil. This would require a sea water pump, not currently available, and protection from corrosion for the interior of the spheres and piping.

PUMPING RATES INADEQUATE The present pumping rate of about one gallon per minute is not considered fast enough, but to increase the rate would require a substantial power increase. The variable ballast pump in Alvin is driven by an electric motor independent of the propulsion systems. If the propulsion hydraulic pumps were arranged so that they could be used to pump variable ballast, substantial gains could be made. This would require the same type of oil to be used in both systems. Alvin carries four different major oils due to conflicting viscosity and density requirements.

WHOI 10.9

MERCURY TRIM SYSTEM The system is shown schematically in Fig. 3. It has functioned satisfactorily since some initial mercury leakage was prevented from recurrence by suitable baffles.

FIXED BUOYANCY Fixed buoyancy is achieved by the use of syntactic foam and by the use of 7178-T6 aluminum spheres. The aluminum spheres have weight to displacement ratio of .35 which, it is believed, is lower than that of any metal vessels manufactured to date for external pressure and having the same collapse strength. The spheres are clamped hemispheres with metal-to-metal mating surfaces and have an external sealing band. They are carried in a surrounding oil bath to avoid stress corrosion to which the alloy is prone. No difficulty or deterioration has been observed to date in this system.

Alvin's syntactic foam was manufactured by Applied Science Division, Litton Systems. It is a vacuum mixed foam of glass microspheres and epoxy resin. The material used in Alvin has been extensively sampled and tested for water absorption and change of buoyancy including a 1,000 hour, 8-hour-cycling test. At the operating pressure of 2,750 psi the glass microspheres do not fracture, as has been the case at higher pressures. Decrease of buoyancy under pressure is due to water absorption by the epoxy resin and voids in the mix. Air drying of the material after pressurization returns it to the original condition. Tests made with small uncoated specimens exhibited satisfactory long-term behavior -- that is, less than 2% change of buoyancy after 1,000 hours. Since this change is a function of surface area exposed to the sea, the material used in Alvin is coated and, therefore, should exhibit much less change in buoyancy.

Syntactic foam is a very useful material for providing buoyancy -- particularly where complex shapes are required. Its one drawback is weight. It is heavier than metallic or non-metallic pressure vessels, though competitive in cost. Current development of foams is reducing the density for a given pressure capability. The material used in Alvin, developed 3 years ago, has an average density of 42 lbs. per cu. ft. Current products, it is understood, have reached 35 lbs. per cu. ft. for comparable performance.

FOREBODY RELEASE The concept of a releasable forebody to enable the crew to escape, in case the afterbody becomes caught in cable, rock outcropping, wreckage or other hazards, is unique with Alvin. The need for such a feature has not been proven, but then, experience with submarines in close proximity to the hazards mentioned is very limited. The release feature does introduce vehicle design complications which compromise frame structural integrity, electrical continuity, and layout flexibility (to name a few), but until experience shows the release to be unnecessary it is felt to be useful. Some deep research vehicles currently in the design stage have envelopes so completely faired that there is very little that could get caught. It is hoped that this approach will prove successful. Meanwhile, the Alvin hull release has operated satisfactorily in sea test and has given no trouble.

ELECTRICAL SYSTEMS When Alvin was designed the choices available in electrical components lay in two widely separated categories with very few in between: (1) Large and heavy equipment proven at sea, but not at the high pressures of submergency to 6,000 ft.; (2) small and light components generally used on land or in the air, though sometimes

used at sea but not on submarines. Since vehicle weight and cost were primary design limitations, the light weight components were used. Generally it was found that wire and connectors sized for the electrical requirement were not mechanically strong enough to stand the wear and tear of runs, bends, and frequent assembly and disassembly. A successful tank test was not enough. The symptoms of trouble were first electrical leakage and then loss of continuity.

A phenomenon first experienced by the bathyscaphe TRIESTE and later by the French bathyscaphe ARCHIMEDE has troubled Alvin as well. The Alvin propulsion box containing Hoover electric motors, pumps, valves, etc., is filled with a special oil at ambient pressure. The oil is required for satisfactory operation of the motors and also acts as an insulator for the electrical components. The control center in which the electrical distribution switches are located is also filled with the Hoover oil. Upon arcing of any electrical contacts the oil dissociates chemically, releasing carbon clinkers which lodge between the contact points. It has not been determined what maximum current is acceptable, what degree of arc suppression is necessary or whether carbonizing occurs with other than Hoover oil. But, the following account of the Alvin problem and its solution gives bounds which may be of some help.

Solenoid-operated four-way valves were used in the main propulsion system and were located in the main propulsion box. Each solenoid had a pull-in coil drawing 30 amp. and a hold-in coil drawing 1.5 amps. Voltage is 30 D.C. Breaker points without arc suppression arced during pull-in at depth, causing carbon formation and intermittent shorting out of contact points. After the contact circuits were held closed by carbon, the control center continued to draw 30 amps. The control center relays have a larger contact area than the solenoid relays and continued to function, though a carbon build-up was observed. The failure was intermittent at the surface and also pressure dependent. The field solution of the problem involved rewinding the valve solenoids so that only one coil was used, drawing about 3 amps. Also, the guilty control center relays were moved into the sphere. The Hoover electric motors have operated satisfactorily. Selenium rectifier arc suppressors are used with the switches. The carbon clinker problem bears further study.

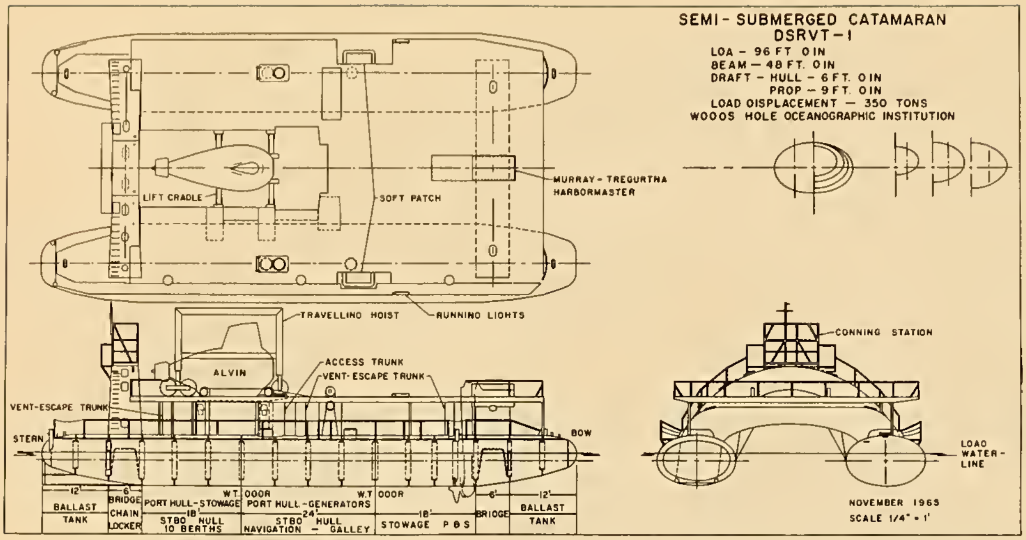
ARRANGEMENT As was mentioned in discussing resistance, the lines of the small research submersible should be dictated by arrangement. Good access to all electrical and mechanical systems must be provided, particularly in these early vehicles which are largely experimental. Battery removal should be simple, not requiring the lifting of the submarine. Plumbing and wiring should be such that major assemblies can be removed easily. Components in the sphere should be easily removed for repair and maintenance outside the sphere. Oxygen bottles within the sphere should be removable for charging so that the sphere will not be tied up for precious hours in between dives by an unnecessary function.

SEMISUBMERGED CATAMARAN -DSRVT-1

A MOTHER SHIP FOR ALVIN During the design and construction phase of Alvin, a number of schemes for handling Alvin at sea were investigated. At that time, the operation of J. Cousteau's Denise (Soucoup) with the 150 foot vessel CALYPSO was the only remotely comparable experience available. Denise was launched and retrived successfully using a deck crane. However, Denise is a much lighter vehicle than Alvin, and the cost of a crane large enough to handle 30,000 lbs. in this way and the operation of a ship large enough to handle such a crane was beyond reach at the time. Attention at WHOI was directed at determining the smallest vessel capable of going to sea with Alvin aboard. Further, it was out of the question to tie up an existing operating oceanographic vessel exclusively for the use of Alvin during a long shake-down period.

A "CAT" IS BORN In the fall of 1963, the U. S. Naval Bureau of Ships made available to WHOI through the Office of Naval Research two large pontoon hulls, each 96 feet long by 14 feet wide by 9 feet deep. They had been used for mine hunting operations and were extremely heavily built to resist underwater explosions. It was decided to design and build a catamaran with these hulls to handle Alvin. This was done, and in April 1965 she left Woods Hole to commence a period of operations at sea in which her performance has exceeded design expectations in every way. For this reason, some detail follows of her evolution and behavior. Because the hulls can be considered as rigid it is easy to make a model. A 1/12 scale simple structural model was made and towed at sea in a variety of sea conditions which were unrecorded, but which, it was felt, simulated anything up to 60 foot seas full scale. Strains were measured and from this bending moments were established for the design of the two bridge structures to hold the hulls together. The results of the test can be summarized simply as follows: If one hull is considered to be a fixed support and the other hull is considered hanging on the ends of the two bridge structures, which thus become cantilever beams, the model test produced bending moments in both the horizontal and vertical plane each equal to one-half that resulting from the cantilever situation described. The hulls have a centerline separation of 34 ft., a between-hull distance of 20 ft., and the model beam was horizontal 1.5 ft. (full scale) above the top of each hull. An analysis of torsional stresses and deflections showed that with large longitudinal separation of the bridges a design meeting the vertical and horizontal bending criteria also gave acceptable torsional stress. Based on the model results, a factor of safety of 3 was applied to the yield point for detail design of bridge structure -- which was performed by P. L. Rhodes of New York.

"CAT" DETAILS & PERFORMANCE In addition to the bridge structure, there is a deck 70 by 45 feet with sufficient support that heavy loads can be placed at most locations. Alvin is moved fore and aft along the center line by a



traveling hoist. The aft bridge provides clearance above water of 12 ft. under which Alvin passes during launch and retrieval. The lifting cradle located aft of amidships is supported by four cables led to electrically driven drums. There is sufficient cable for Alvin to land on the cradle submerged, but this has not been attempted as yet. The catamaran contains generating equipment, quarters, galley, electronics shop, machine shop, charging equipment, air compressors, and is generally designed to operate for periods of time away from a civilized base. An important item of load is the large amount of fresh water which must be carried for the daily washdown of Alvin to remove saltwater. Propulsion is by means of a large Murray & Tregurtha outboard unit mounted on the centerline forward. This is adequate for maneuvering and short ocean passages, but she has, in the past, been towed for long ocean passages. She has covered 3,600 miles in open ocean passages to date. It is planned to mount two 200-horsepower Murray & Tregurtha outboard engines aft to increase passage making capability as well as maneuverability. The catamaran has ridden sustained seas up to 25 ft. in height. She has ridden substantial seas at all attitudes and has proved to be a dry and stable platform. The launch and retrieve operation has been performed in State 4 seas and planned refinements to the handling equipment should increase this capability. The problem of landing Alvin on a cradle, initially considered the major difficulty, has turned out to be no problem because of the similar motion of Alvin and the catamaran in a seaway. The load displacement of the catamaran is 350 tons, which floats her hulls at a draft of 6 ft. Since they are elliptical in cross-section, the water-place area is reduced when heaving, giving a behavior similar to that of a surfaced fleet submarine. Reserve buoyancy is low, but safety can be assured by sufficient watertight integrity. Roll and pitch of the catamaran have been measured in 20 ft. seas. A maximum of 12 degrees roll and 10 degrees pitch was found. These should be compared with the motion of a typical 350 ton single hulled vessel of, say, 125 ft. length under similar conditions. Further, a light-displacement catamaran of this size can be expected to have considerably more violent motion.

"CAT" NO JACK-RABBIT BUT IS STABLE It is difficult to visualize the semi-submerged catamaran as a high speed vessel, but submarine-tending along with some other oceanographic missions require primarily a vessel that can keep station and remain stable in a seaway.

Fortunately, from the point of view of gaining rough water experience, and unfortunately from the point of view of achieving a maximum number of hours submerged, Alvin has operated in rough seas a lot of the time. Sea states greater than those permissive of safe launch and retrieval have cancelled many dives while the catamaran and crew were at sea on station. In the North Atlantic, seas of 8-10 ft. are common in all but the summer months. All this leads to the suggestion that surface operation of small deep submersibles in areas where, and at times when, rough seas are common may well remain a serious problem for some time. It would appear that the ultimate solution will be the launch and retrieval of small submarines by larger, submerged submarines.

PROCEDURE USED FOR ALVIN LAUNCH - RETRIEVAL

LAUNCH IS REVERSE OF RETRIEVAL The launch procedure is essentially the reverse of retrieval, without the necessity of making initial contact between submarine and catamaran. In retrieval, the catamaran positions herself bow to the seas and to windward of Alvin for the initial contact. As Alvin approaches the stern under her own power, lines, three on each side, are led from the catamaran and secured aboard Alvin using a rubber boat or swimmers. The lines are handled manually on cleats as Alvin drives between the hulls under her own power to a position over the lowered cradle. In addition to the 4 lifting cables, the cradle in its lowered position is restrained by one manually-controlled line to each catamaran hull. Eight lines, of course, mean eight line handlers are required to keep Alvin and her cradle centered within the catamaran and to prevent fore and aft surging. While the pilot of Alvin is in the conning tower guiding her in, the other man aboard is below

looking out of the bottom window where he is able to observe the position of Alvin relative to her cradle. The Alvin keels are landed on one-inch rubber padding on the cradle.

SEA STATE 4 RETRIEVAL In State 4 seas the landing of Alvin on her cradle takes place with no noticeable impact and both are then lifted smoothly up to the stowage position. As Alvin and cradle leave the water they are subject to some pendulum action both fore and aft and athwartships, but due to the inherently low accelerations of the catamaran, this motion can be controlled by hand-tended lines in seas up to and including State 4.

"CAT" & ALVIN MOTION SIMILAR The motion of Alvin on the surface and the catamaran are very much alike in a seaway. For this reason, the launch and retrieval operations have been more successful than anticipated. While a head to sea attitude of the catamaran is desirable for initial contact, a beam to the sea attitude may be better once Alvin is between the hulls. Operations have been carried out successfully in both head and beam seas.

LIMITING FACTOR The initial entrance of the submarine between the catamaran hulls before she is secured with three lines on each side, is a critical part of the operation and may be the limiting feature in considering the technique for higher sea states. Improvements are currently underway which include a centerline hauling winch and three line handling winches on each side. Also a more positive control of the cradle during ascent and descent is planned.

ACKNOWLEDGEMENTS

In writing this account, the author has drawn from the experience of many members of the Alvin operating crew and staff of the Department of Applied Oceanography, Woods Hole Oceanographic Institution. The manuscript was reviewed by Dr. Earl E. Hays and William O. Rainnie, Jr., and their helpful suggestions are appreciated. Alvin was designed and built by Litton Systems, Applied Science Division.

The Deep Submergency Research Vehicle Project at the Woods Hole Oceanography Institution is supported by Contract No. 3484 with the Office of Naval Research, Director of Underseas Programs, Code 466.

REFERENCES:

* WHOI Ref. 65-32 "Observation Windows of the Deep Submersible, Alvin" by J. W. Mavor, Jr. December 1965.

WHOI Tech. Memo M-DS-19 "Fuse Testing in Oil for Alvin Batteries" by M. J. McCamis, W. M. Marquet, G. Broderson, and D. Mason. February 1965.

WHOI Tech. Memo TM-DS-19 "Weight, Buoyancy, and Stability Report on the Alvin vehicle as of May 17, 1965." by J. W. Mavor, Jr. May 1965.

"Alvin Trial Specifications", by F. P. Omohundro, April 1965 DSRVG Report.

WHOI TM-DS-15 "Summary Report on Fabrication, Inspection, and Test of Alvin Fixed and Variable Buoyancy Spheres", by J. W Mavor, Jr. January 11, 1965.

WHOI TM-DS-18 "Weight, Buoyancy, and Stability of the Research Submarine, Alvin", by J. W. Mavor, Jr. February 1965.

* WHOI Tech. Memo TM-DS-20 "Design and Manufacture of New Emergency Hull Release for Alvin, by J. W. Mavor, Jr. and A. G. Sharp. August 1965.

* WHOI Ref. 65-11 "Deep Submergence Research Conducted During the Period 1 January through 31 December 1964", by DSRVG, February 1965.

* WHOI Ref. 65-1 "The Mechanical and Chemical Properties of the HY100 Pressure Hulls of the Submarine, Alvin", by J. W. Mavor, Jr. January 1965.

WHOI Tech. Memo TM-DS-12 "Twenty-Four (24) Manhour Test of Alvin's Environmental System" by W. M. Marquet et al, dated November, 1964.

WHOI Tech. Memo TM-DS-14 "Specifications and Analysis of Proposed Titanium Alloy Buoyancy Spheres for Alvin", by J. W. Mavor, Jr. December 18, 1964.

"Alvin Hull Penetrator Test" by E. M. Briggs and R. C. Dehart. SWRI Project 03-1206. May 1964.

"Experimental Stress Analysis for Alvin Hull No. 2", by E. M. Briggs R. C. Dehart. Revision May 1964.

"Experimental Stress Analysis of Alvin Buoyancy Spheres", by E. M. Briggs and R. C. Dehart. October 1964.

WHOI 10, 11

WHOI "Management Plan for Deep Sea Research Vehicles", WHOI. April 1965.

* WHOI "Deep Submergence Research conducted 1 November 1961 - 31 October 1962. WHOI Ref. 62-41. November 1962.

ORE, "An Investigation of the Performance of Hollow Glass Spheres at Pressure", Ocean Research Equipment, Inc. Report 04641, April 13, 1964.

ORE, "Pressure Tests of Plexiglas Windows of Alvin Submarine", Ocean Research Equipment, Inc. Report 04651. April 9, 1965.

Litton ASD, "Alvin High Pressure Test Report" Applied Science Division Litton Systems, Inc. July 24, 1964.

* WHOI Reference 64-1,"Deep Submergence Research conducted during 1 November 1962 - 31 December 1963.

H. Froehlich, E. Klemp and R. Meinhardt, "Alvin Buoyancy Material Test Report of Vehicle Core Samples", Litton ASD Report, November 17, 1964.

H. Froehlich, E. Klemp, R. Meinhardt "Alvin Buoyancy Material Test Report", Litton ASD Report. August 28, 1964.

E. Kemp, D. Nelson, "Test Report, Stress vs. Pressure of 6061 Aluminum Spheres Pit Repair", Litton, ASD Report. February 23, 1965.

* D. J. Bynum, R. C. Dehart "Experimental Stress Analysis of a Model of the Alvin Hull", SWRI Report, April 3, 1963.

* "Structural Design of a 6000 Foot Submergence Manned Oceanographic Vehicle", by J. W. Mavor, Jr.

** Proceedings of DTMB Workshop on Deep-Submergence Hulls. 3,4,5, December 1962. Published in DTMB Report (Confidential).

* "Alvin, An Oceanographic Research Submarine" by Joseph B. Walsh and W. O. Rainnie, Jr.

** ASME Annual Meeting, Philadelphia, November 21, 1963. Published in Mechanical Engineering, Vol. 86, August 1964.

* WHOI Ref. 62-41 "Deep Submergence Research Conducted During the Period 1 November 1961 - 31 October 1962". November 1962.

* "Experimental Stress Analysis and Leak Test for Alvin Hull No. 1", by E. M. Briggs and R. C. Dehart, dated 18 September 1963. SWRI Project 12063.

WHOI Tech. Memo TM-DS-1 "Electrical and Pressure Tests of Alvin's Electrical through-Hull Penetrators" by M. J. McCamis et al. November 1964.

* ** "Predictions of the Collapse Strength of three HY 100 Steel Spherical Hulls Fabricated for the Oceanographic Research Vehicle Alvin" by Thomas J. Kiernan. March 1964.

"Surface Stability and Underwater Drag Investigations on the Alvin Oceanographic Submarine" by T. Paul Torda. August 12, 1964.

* Originally published in substantial quantity. ** Published and given wide initial distribution. Only the references marked "*" or "**" can be considered as being generally available.

NOTE: Alvin is currently in Spain assisting in the search for the missing thermonuclear device at approximately 37°8'N by 1°42'W. See page 25 this issue.

Book Review

"FERTILIZATION" By C. R. Austin. 1965. Prentice-Hall, Inc. Englewood Cliffs, N. J. Drawings and photographs. Indexed. 145 pages. $2.95 paperbound, $4.95 clothbound. Marine biologists and students will be interested in this book which deals exclusively and comprehensively with fertilization, a phenomenon common to both animals and plants. Chapter One gives basic information on cell structure, growth and division; subsequent chapters trace the process of fertilization, giving many examples. A wide variety of organisms are included, from algae to toadfish to man. We're always glad to see a reasonably priced text. -- C. R. S.

"RESTORING THE QUALITY OF OUR ENVIRONMENT" Report of the Environmental Pollution Panel, President's Science Advisory Committee, 1965. The White House. Indexed. 317 pages. A readable government report which covers every conceivable environmental pollutant, including unsightly abandoned cars. The report describes the effects and sources of pollution and gives sensible recommendations for dealing with the problem--actions, research, and manpower among them. The appendices make up the bulk of the report and are interesting and frightening. Of Raritan Bay and its adjacent waters: "A previously profitable shellfishery is prohibited and the few remaining commercially valuable fishes taken from its waters are unmarketable because of an unpalatable taste which the polluted environment imparts to their flesh." And: "The unpleasant odor of a rendering plant, the noise of a jet airplane or of the other fellow's transistor radio, disorderly jumbles of auto hulks, unsightly trash in a dump, all are irritating and offensive. All will require increasing attention." This report affects all of us. Read it if possible. Written by scientists and engineers from the Federal Government, state governments, universities and industry. -- C. R. S.

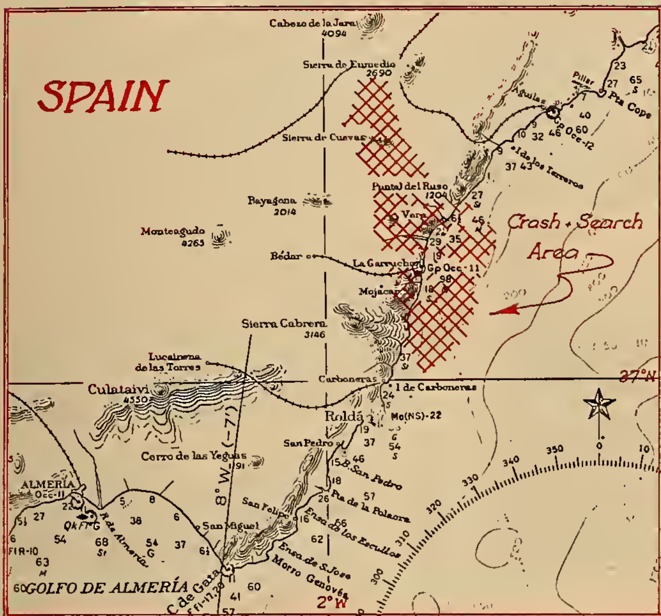
"THE MINERAL RESOURCES OF THE SEA" By John L. Mero. 1965. Elsevier Oceanography Series. Illustrated with photos and drawings. 312 pages. $9.75. Dr. Mero, in a thin, 312-page book has covered much of the known information on the recovery of minerals from the ocean and its floor. When we compare his book to the vast libraries on mining operations on the other 30% of the earth, it is incredible that this hasn't been written before. It's hard to believe that ocean mining is this recent. Starting from the shore Mero describes marine beach minerals and mining operations, minerals in sea water, and extraction methods, continental shelf minerals, deep sea floor minerals, ocean mining and finally the legal aspects of ocean mining. One-third of the book is on manganese nodules, their formation and recovery. Dr. Mero stresses the tremendous value of this unique ocean floor deposit. This is an interesting book with good illustrations and a good index. -- C. R. S.

"ADVANCES IN HYDROSCIENCE, Volume I" Edited by Ven Te Chow. 1964. Academic Press, New York and London. $15.00. 442 pages. "Hydroscience" is the first of a serial publication on data emerging from the study of water. Not for general reading, it is packed with formulas, tables, graphs and diagrams. Volume I consists of five articles by authors from the Navy Electronics Lab, Admiralty Research Lab in England, New Mexico Institute of Mining and Technology, Portsmouth Hava, Shipyard and the University of Illinois. The series was started with the object of gathering information on the science and technology of water into one publication. "The ever-increasing scientific research on water has already resulted in a large body of new knowledge which...can only be found scattered through various scientific journals and technical reports..." The articles are on sonar, hydroelasticity, statistical hydrodynamics, hydroballistics, and wells. Perhaps this is a good thing. In the introduction the "information explosion" is mentioned. One of the big problems facing scientists today is searching the literature, and it is getting worse daily. Information should, of course, be published as quickly as it can, but there must be some better way than starting still more new series. -- C. R. S.

"INTRODUCTION TO PALEOECOLOGY" By R. F. Hecker. American Elsevier Publishing Co. 1965. Transl. from the Russian by M. K. Elias and R. C. Moore. Bibliography. Index. 166 pages, $7.50.

Paleoecology is the study of where and how animals and plants lived in the geological past, and "Introduction to Paleoecology" gives down-to-earth instructions for collecting, preparing, illustrating and photographing these fossil assemblages. The book is translated from the original Russian and is a valuable addition to our Englishlanguage literature. Those of us interested in fossils and fossil collecting will want to own the book. The drawings, of course, for the most part illustrate areas in Russia -- in some ways a handicap to readers. -- C. R. S.

ON STATION:



LOST: ONE H-BOMB

The search for the missing nuclear device off the coast of southeastern Spain emphasizes once again our limitations with respect to deep ocean search and recovery--though no one will argue the fact that we were much better prepared for this one than we were for trying to find SSN-593 Thresher. For background: On January 17 a U.S. Strategic Air Command B-52 bomber from the 68th Bombardment Wing, Seymour Johnson Air Force Base, N.C., rendezvoused over the southeastern part of Spain with a KC-135 tanker from the 910th Air Refueling Squadron, Bergstrom Air Force Base, Texas. While DOD admits nothing officially, whe B-52 (described as being on a "training" flight) was apparently carrying four nuclear devices. During the refueling operation, the two aircraft collided in the vicinity of Cuevas del Almanzora in the Province of Almeria. This is approximately eight nautical miles northwest of the nearest point on the Mediterranean coast. It is customary for B-52's to conduct refueling operations at altitudes of 25,000-to-30,000 feet and at air speeds in the vicinity of 200 knots.

Some of the wreckage fell in the vicinity of Cuevas del Almanzora, some near Vera about 7.5 nautical miles SSE, and yet additional debris in the area of La Garrucha, some 5.5 mi. still farther SSE and on the coast. Bombs and/or parts of bombs were apparently strewn all along the way. At least, radioactivity warnings have been issued by the mayors of all three towns. As GMT went to press, three of the devices had been found ashore, and the search for the fourth had turned to the sea. One crewman was found alive at Vera; three were rescued from the Mediterranean; five died, and two are listed as missing.

In this area, there is virtually no continental shelf. From La Garrucha the 100-fathom line is slightly over three nautical miles offshore; the 200-fathom line is only five miles distant at the nearest point; while the distance to the 300-fm. line (nearest point) is 7.5 miles (see Navy Hydrographic Office chart BC3915N). The water is not very clear. Nor is the surf zone considered to be excessive -- thus reducing the problems of searching this area.

Meanwhile, the U.S. Air Force, Navy and Department of Defense clammed up on saying anything about anything. Officially they refused to admit they were looking for anything -- all the while scurrying about madly trying to figure out how to find and recover it. They turned to the available stable of deep submersibles, to find the following:

Dr. Jacques-Yves Cousteau's diving saucer (Soucoup) was in the middle of its annual overhaul; would take 15 days to re-assemble. Also, it's restricted to a depth of 1,000 feet. Trieste 1 is no longer operational according to Navy. Trieste II is being overhauled and modified; won't be usable until March. Deepstar 4000 was partially dissembled for certification inspection; had only been tested to 600 feet; but could be ready for air shipment in two days. The existing Perry Cubmarines, Asherah, Star 1, and Benthos V, lack (one or more of) depth capability, load-carrying capacity, sufficient hatch size, and/or electric power capacity necessary to carry side-looking sonar to the required depth. This left Alvin, Aluminaut and Deep Jeep. Alvin carries Straza high-resolution forward-looking sonar and a mechanical arm, but no side-looking sonar (nor could it be fitted in time). Deep Jeep lacks sophisticated search gear and mechanical arm. Aluminaut carries Straza scanning sonar, closed circuit TV and Westinghouse side-looking sonar. Side-looking sonar is considered necessary for practical search. A mechanical arm may be necessary to effect device recovery when and if it is found.

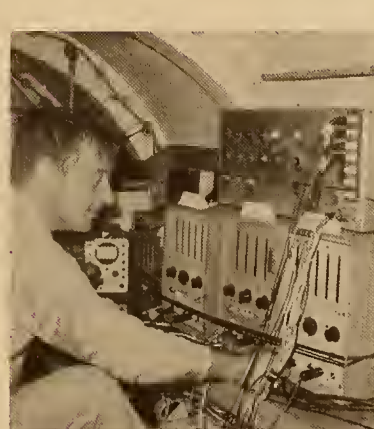
By February 10, both Aluminaut and Alvin were on station -- Alvin by air and Aluminaut by sea on board an LSD. As GMT went to press the device still hadn't been found and positively identified. Even side-looking sonar has its limitations. The device they were looking for is on the order of 6-to-8 feet long, about two feet in diameter. For side-looking sonar to see a target this size, it would have to be within 200 feet on the high-resolution scale. Even then, positive identification probably couldn't be made without direct visual or TV inspection. Nor would a magnetometer probably be of much use. Assuming that the bomb's outer case is made of some lightweight material, such as aluminum, most of the device's innards are either non-magnetic or only weakly magnetic. One thing that might be of use -- though we doubt if it is being used -- would be a "spontaneous potential detector". This is a French undersea adaptation of a fairly common oil-well-logging instrument. It relies on the fact that any metallic object in an electrolyte -- whether magnetic or not -- polarizes and produces a sensible electrical field.

If the devices is a thermonuclear bomb, which seems entirely likely, its fusion charge in all probability consists of deuterium and/or tritium in the form of hydrides of lithium-6. Lithium hydride reacts rather violently with water to produce H_2 and LiOH. Considering the fact that the bomb probably wasn't designed with corrosion due to long immersion in seawater in mind, it seems likely that sooner or later the ocean will get in. Maybe, in the end the bomb will be located by its bubbles.

Another system being used to hunt for the device was the Boomerang corer. Some 200 of these have been produced by Benthos Co.; Navy collected as many of these as it could find and had them all shipped to the search site. The idea was that if the device had broken apart, traces of radioactivity would be present in nearby sediments. Advantage of the Boomerang corer is its speed and ease of deployment. It is simply thrown over the side to free-fall to the bottom. Upon impact it drops ballast and then rises back to the surface with its core sample--where a flashing Xenon light inside a glass buoyant sphere aids recovery.

ALUMINAUT CHECKS OUT DSSP DOPPLER NAVIGATOR

Last month DR/V Aluminaut successfully checked out the Janus doppler sonar being considered for deep-ocean search and rescue vessels under development by the DSSP (Deep Submergence Systems Project) of the U.S. Navy. Site of the test was under



the Gulf Stream in about 2,200 feet of water approximately off of Miami, Fla. In order to test the navigation system, it was necessary to place a "range" on the ocean floor. This consisted of a 150-foot-long, two-inch diameter aluminum pipe, with a triplane acoustic reflector located at either end. Considering that Aluminaut's mechanical arms still haven't been fitted to the craft, the placing of this "range" required considerable ingenuity. The pipe was suspended by divers under and in line with Aluminaut. An "articulated device with a 100% assurance of releasing a snap fastener" was rigged and connected to the TV pan and tilt mechanism at Aluminaut's bow. Using this device, which Reynolds Submarine Services, Inc., won't talk about in any more detail, the "range" was emplanted on the ocean floor aligned to within 2° of the southward-running seafloor current at that location. The doppler navigator, incidentally, proved accurate in its tracking capabilities to within 3%. In this dive, Aluminaut was submerged for a total of about seven hours.

U. S. NAVY CONCENTRATES OCEAN SCIENCE EFFORTS — Not so gradually any more, the Navy is concentrating all of its basic scientific oceanographic efforts geographically at the U.S. Naval Research Laboratory, Anacostia, Md., just outside the Nation's Capital. Nearly 200 scientists and technicians have been moved from Navy Oceanographic Office, as have four codes from Office of Naval Research. While reorganization was effective December 15, 1965, Navy still hasn't settled on details. Meanwhile, the new group is called the Ocean Science & Technology (Branch, Division, Office, Group, etc.) -- the last word of the title not yet having been determined. Navy's reasons for this move aren't really clear. The scientists, however, seem to favor it: "We got a chance to talk to one another." Properly managed and supported, it could become a very powerful and productive group. Improperly handled, however, it could be detrimental, but still powerful.

DSSP NOW PART OF NAVAL MATERIEL — As of February 1, 1966, the Deep Submergence Systems Project (DSSP) was moved out of the Special Projects Office (SPO), expanded, and placed directly under the control of the Chief of Naval Materiel. Its probable redesignation will be PM-11, which stands for "Project Management," BuShips will provide "housekeeping" services, but will have no authority over its direction. Dr. John Craven, SPO chief scientist, is acting director of PM-11.

Role of PM-11 will be greater than DSSP. In addition to designing, developing and building small deep diving submarines--for which DSSP originally was created--PM-11 will develope and prove out new pressure hull designs and materials, new propulsion and control concepts, new communication and navigation techniques, and, conceivably, whole new concepts of deep ocean operations.

LAKES RESEARCH CONFERENCE — The Ninth Conference on Great Lakes Research, to be held in Chicago, March 28 to 30, will cover such topics as water quality and budgeting, lake basin geology, current patterns, weather, pollution studies and the management and economic development of the lake system. Sessions will also include papers on organic and inorganic

Reprinted from

NAVAL RESEARCH
REVIEWS

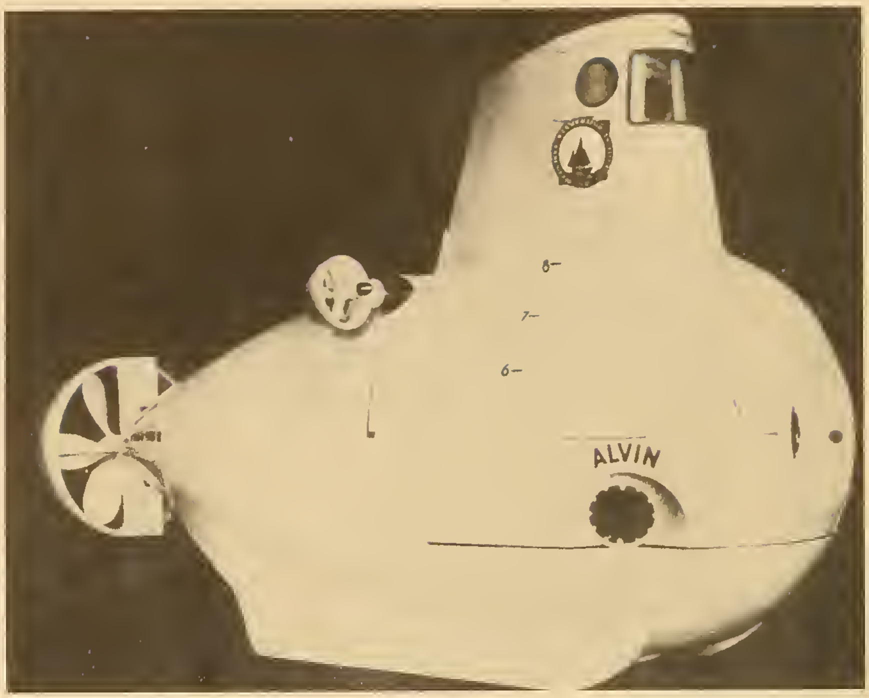
ALVIN's World

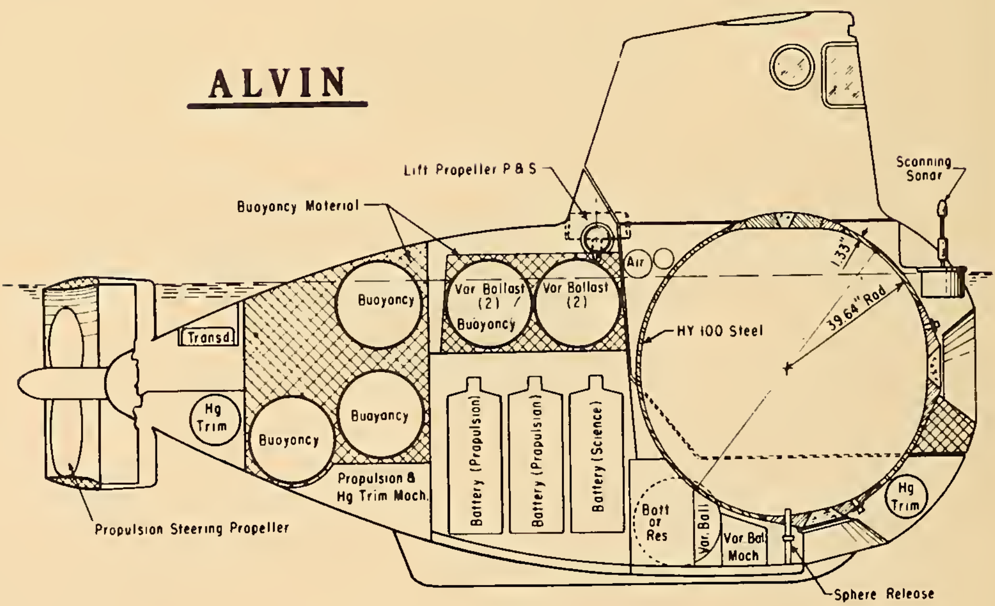
Hon. James H. Wakelin, Jr.
Assistant Secretary of the Navy
(Research and Development)

OFFICE OF NAVAL RESEARCH

DEPARTMENT OF THE NAVY WASHINGTON, D. C.

WHOI N. 2





Longitudinal section of ALVIN

WHOI H. 3

ALVIN's World

Hon. James H. Wakelin, Jr.
Assistant Secretary of the Navy
(Research and Development)

Over these past years, I have witnessed tremendous progress and accomplishment in the scientific endeavors made in support of the National Oceanographic Program. Of special interest has been the increased emphasis on the exploration of the deep ocean—the last true frontier on this planet.

Shortly after I took office, the bathyscaph TRIESTE made its historic 35,800-foot dive to the bottom of the Marianas Trench off Guam. Although this was a record dive and a notable "first," we of the Navy recognized that the event, in itself, made only minor contributions to science; it was important, rather, as one in a series of controlled tests designed to prove TRIESTE's capabilities for deep-ocean research. I think this point was lost to many people at that time. Coming as it did on the eve of manned exploration of space, the feat itself attracted more interest than its true meaning in terms of the future scientific investigation of the sea.

I emphasize this past history because I think too often we tend to stress the spectacular—the record altitudes and speeds, the *machine* rather then the intended *purpose* of the machine. This inclination is not unique to deep submersibles. All of us have witnessed the spectacular growth of aeronautics from the propeller-driven aircraft of World War II to the manned space flights of today. Like millions of Americans, we have followed eagerly the achievements of a rapidly accelerating technology—a technology that hopefully will put our astronauts on the moon within the next decade. But our attention tends to be focused on the hardware, on the pilot, and on the "firsts." All too often the intended purpose of the mission is forgotten.

I, for one, do not subscribe to the apparently sacrosanct belief that the mountain should be climbed because it is there, that a certain altitude or depth should be achieved because no man has previously flown or plunged so far. I believe that tools are developed to achieve a purpose. In a day when the development of tools demands such tremendous national resources, this purpose must be responsive to the interests of the Nation and its people.

---

*A slightly modified version of the address given by Dr. Wakelin at the commissioning of ALVIN at the Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, June 5, 1964.

ALVIN is one such tool. Although its designed depth of 6,000 feet is considerably less than that of TRIESTE, the speed, endurance, maneuverability, and range of ALVIN, plus its self-contained ballast system, permit us to call it a submarine. It will be the first deep-diving submarine to go into operation anywhere.

The men who are privileged to dive in ALVIN will see things that will undoubtedly make news for many years to come. But those of us in the Navy, industry, and at Woods Hole who helped conceive and bring her into being will be more concerned, I hope, over its impact on scientific research, particularly basic research important to the national interests. Our purpose is to advance man's knowledge of the sea; ALVIN is but one means to this end.

We have other objectives in the oceans besides research that demand tools for use in the deep-sea environment. Deep-diving military submarines are expanding the potential arena of naval warfare. We must understand this new and demanding environment. We must also be able to live and work in it.

The tragic loss of the submarine THRESHER emphasized the pitiful inadequacy of our present technology to plumb the ocean's depth and perform useful work on the ocean's floor. Ship-lowered cameras, precision depth recorders, and other advanced oceanographic instrumentation were mobilized behind the search. But, in effect, we were groping blind from the surface. I know I speak for many of the men who joined the search for the THRESHER when I say that we were especially frustrated at our inability to employ the best sensor of all—the mind and eyes of man.

Eventually we were able to bring TRIESTE into the search. Her dives demonstrated clearly the advantage of selective, personal observation. Observers were able to confirm and photograph the location of structural parts of THRESHER on the ocean floor. In one of its dives, the bathyscaph used its mechanical arm to retrieve a length of copper pipe bearing markings which definitely established that it came from THRESHER.

But TRIESTE was not designed for search and recovery. It is in reality a slow, awkward, deep-sea elevator having little horizontal mobility, which greatly limits its area of coverage. Clearly, a new-generation deep-diving submersible must be perfected for this specialized work.

In April of last year, the Secretary of the Navy convened a group of prominent submarine officers, marine engineers, and oceanographers to prepare recommendations on what capabilities the Navy would require to locate, identify, rescue, and salvage objects of all sizes at any depth on the ocean's floor. In late May, the Secretary approved the recommendations of this group. Soon to be launched will be a program to advance our technology sufficiently to perform a variety of military missions in the deep ocean. The Special Projects Office will spearhead this effort;

its past accomplishments on the POLARIS project augurs well for the Navy's new deep-submergence program.

I would like to emphasize here that the vehicles and techniques presently under consideration by this group will not be developed primarily for oceanographic research. Certainly, the program will be of tremendous interest to the scientific community; in fact, we are depending in large measure on its support. But here again we are speaking of tools and purpose. Our main purpose in this respect is submarine rescue and salvage, and I think it would be unfortunate to confuse this purpose with oceanographic research.

On the other hand, I am confident that the technology resulting from the Navy's deep-submergence program will profoundly affect the development of structures, materials, and techniques needed to build the many tools of oceanographic research and ultimately those tools and engines needed for exploitation of the ocean's abundant living and mineral resources. I have in mind deep-diving submersibles to perform geological and geophysical exploration, to drill oil wells, and to mine minerals over the 71 percent of the earth's surface covered by ocean; tools to build underwater structures, such as tunnels, cables, and perhaps eventually villages beneath the sea; and deep diving submarines for tracking and observing commercially valuable fish, for fishing and aquaculture, and even for expanding our already flourishing sea-borne commerce.

Such predictions, no matter how fanciful they may seem today, will require expanded knowledge of the sea. This knowledge can be developed only through scientific research. The job is so big that vehicles needed for research must be designed and built for this specific purpose and no other.

The first such vehicle is ALVIN. With ALVIN we can greatly accelerate the exploration of the vast ocean depths. Nearly one half of the water volume of the ocean and neighboring seas will be accessible to the scientists who will use her. This area includes most of the life of the sea. ALVIN will be capable of exploring one-sixth of the ocean's bottom—an area almost equal to the surface of the moon.

ALVIN will help solve many of the practical problems long tolerated but never really accepted by the sea-going scientist. I understand there is a saying among biologists that towing a sampling net through the ocean is like running madly through an open field blindfolded holding a butterfly net above one's head. ALVIN will put the biologist where he belongs—in the center of the marine environment with his net and eyes open. Here he will be able to observe directly the concentrations and behavior of marine populations. The interaction of animal life and the environment can be studied throughout the water column.

Ideally, the marine geologist would like to do on the sea floor what he does on land—walk or fly over areas of interest, collect specimens, and

WHOI 11, 6

study and map significant features and phenomena. ALVIN is the first step toward eliminating present blind, hit-or-miss methods of bottom sampling. The geologist, instead of groping awkwardly from a rolling platform thousands of feet above his rock dredge or poking random holes in the ocean floor, will finally be able to make discriminating, personal observations. Samples can be collected with ALVIN's mechanical arm, and photographs can be taken with its cameras.

The vessel also promises to be of great value in physical oceanography. The speed and direction of undersea currents can be measured more accurately. As ALVIN drifts slowly downward through the water column or uses its propellers for vertical movement, scientists can obtain continuous profiles of temperature, salinity, and other water characteristics. Other potential uses of ALVIN, some of which cannot now be anticipated, will be made as this research tool extends the eyes and ears of oceanographers to the unexplored regions of the ocean's deep frontier.

ALVIN and the deep-diving research vehicles that will undoubtedly follow her promise sufficiently exciting dividends that I have requested the Interagency Committee on Oceanography, of which I have been privileged to be chairman for the past five years, to prepare a plan that will allow our member agencies to apply this unique tool to problems important to national security and welfare. I believe our optimism is well founded. Future development and wider use of the deep-diving research vehicle will depend in large measure on operational experience and research results. ALVIN, as a new research tool, is expected to play a major role in providing this essential experience while advancing the science of the sea.

As we inaugurate this great new adventure into the realm of the unknown beneath the sea, we should recognize especially the imaginative planning and determined efforts of the several organizations that have turned ALVIN from a concept into a reality. The Office of Naval Research, Woods Hole, the Bureau of Ships, and Litton Industries and its several subcontractors all have made some vital contribution.

To all of the men who have helped plan, design, and construct ALVIN, we can say that you have done your job magnificently. To the men who will operate this pioneer submarine and conduct its research program, we wish you well and note with a touch of envy the exciting challenges that await you in the ocean's deep frontier.

WHOI 11.7

What Makes ALVIN Run

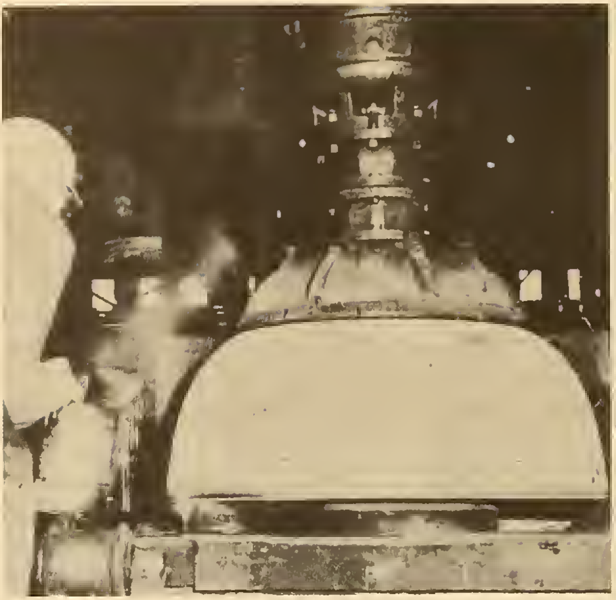
When the deep-submergence research vehicle ALVIN was commissioned at Woods Hole, Massachusetts, last June, one sixth of the ocean bottom—an area almost equal to that of the surface of the moon—was opened to exploration by man. The kinds of investigations ALVIN will make in that realm and the significance of those undertakings to the Navy, the scientific community, and the Nation are discussed by Assistant Secretary of the Navy (R&D) James H. Wakelin, Jr., in the preceding article. Described in the following paragraphs is the vehicle itself—its major features, instruments and equipment, method of operation, safety provisions, and the testing program, which is now underway.

The commissioning of ALVIN on June 5 marked the successful fulfillment of efforts on the part of many people in research laboratories, industry, and the Navy to provide marine scientists with a means of descending safely many thousands of feet into the ocean to view objects of interest first hand. The need for such a vehicle has been recognized for some time by the Navy, oceanographic institutions, and by other organizations. In 1962, therefore, the Office of Naval Research provided inspiration and funds for the design and construction of ALVIN for use by the Woods Hole Oceanographic Institution to facilitate its investigations, which are supported largely by ONR. The Bureau of Ships assisted in the preparation of performance specifications for ALVIN, and the Applied Sciences Division of Litton Industries (formerly the Electronics Division of General Mills, Inc.) designed and built the craft.

Major Features

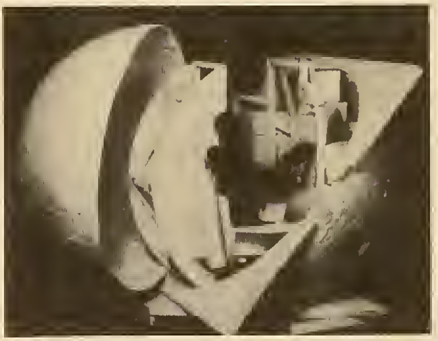
ALVIN is 22 feet long, has an 8-foot beam, displaces 13 long tons, and has a draft of 8-1/2 feet when riding on the ocean surface. It has a top speed of about 8 knots, a cruising speed of 2.5 knots, and a range of 20-25 miles. ALVIN was designed to operate at a depth as great as 6,000 feet, with a safety factor of 1.8, although the personnel sphere has significantly greater depth capability. The pressure sphere, which is slightly less than seven feet in diameter, is made of HY 100 steel 1.33 inches thick. There is room in the sphere for a pilot and one observer and for instrumentation and life-support equipment sufficient to sustain the crew for 24 hours or more. Four viewing ports permit the pilot and observer to see ahead of and beneath the vehicle. The only openings in the hull are the hatch and an emergency sphere release; all other connections between the inside and outside of the sphere are electrical, with the wires passing through specially designed fittings. The power for the vehicle comes from three conventional lead-acid

WHOI 11. 8



One of the half spheres which make up the "heart" of ALVIN—the compartment which operator and scientist will occupy on ALVIN's deep dives—is shaped on a giant potter's wheel. Two heads welded together form a 6-foot, 10-inch cabin capable of withstanding pressures greater than 2700 pounds per square inch.

In this model of ALVIN's pressurized compartment, the two half spheres making up the compartment are opened to show positions of operator and equipment.



batteries located in external packages that may be dropped in an emergency.

The vessel is driven by three propellers, which are controlled by a "joy stick" inside the sphere. On each side of the craft is a small "lift" propeller that is rotatable so its thrust can be directed up or down, ahead or astern. A large propeller, located at the stern, can be turned from side-to-side to steer the vehicle in the same manner that an

outboard motor is turned to steer a conventional small boat. The two lift propellers are separately reversible to provide increased maneuverability; the vehicle can turn on its own axis by reversing one and going ahead on the other. The propellers are driven by reversible hydraulic motors powered by hydraulic pumps which are powered by electric motors encased in oil. All of these components are located outside of the pressure sphere.

To control fore and aft angles of the vehicle, a mercury trim system has been installed. This system consists of two trim tanks, located near the bow and stern, which are normally half full of mercury and half full of oil. The tops and bottoms of the two tanks are connected with piping so that as oil is pumped from the top of one tank to the top of the other, mercury is forced from the bottom of the second tank into the bottom of the first tank. Thus, fore and aft trim angles as large as 30 degrees can be applied.

To compensate for differences in the weight of personnel and instruments and for changes in the density of sea water, a variable ballast system is included in the vehicle. This system utilizes interconnected pressure-proof aluminum spheres and collapsible rubber bags that are filled partly with oil. As oil is pumped from the spheres into the rubber bags, the amount of sea water actually displaced by the vehicle is increased (and thus the buoyancy is increased) while the weight of the vehicle remains the same. The effect is to make the vehicle "lighter." When oil is pumped from the collapsible bags into the spheres, the vessel becomes heavier. It is therefore possible, within the weight limitations of the system (about 600 pounds), to adjust the vehicle for neutral buoyancy throughout its operating-depth range. The craft also has an air system for blowing the main ballast tanks on the surface to provide freeboard and surface stability.

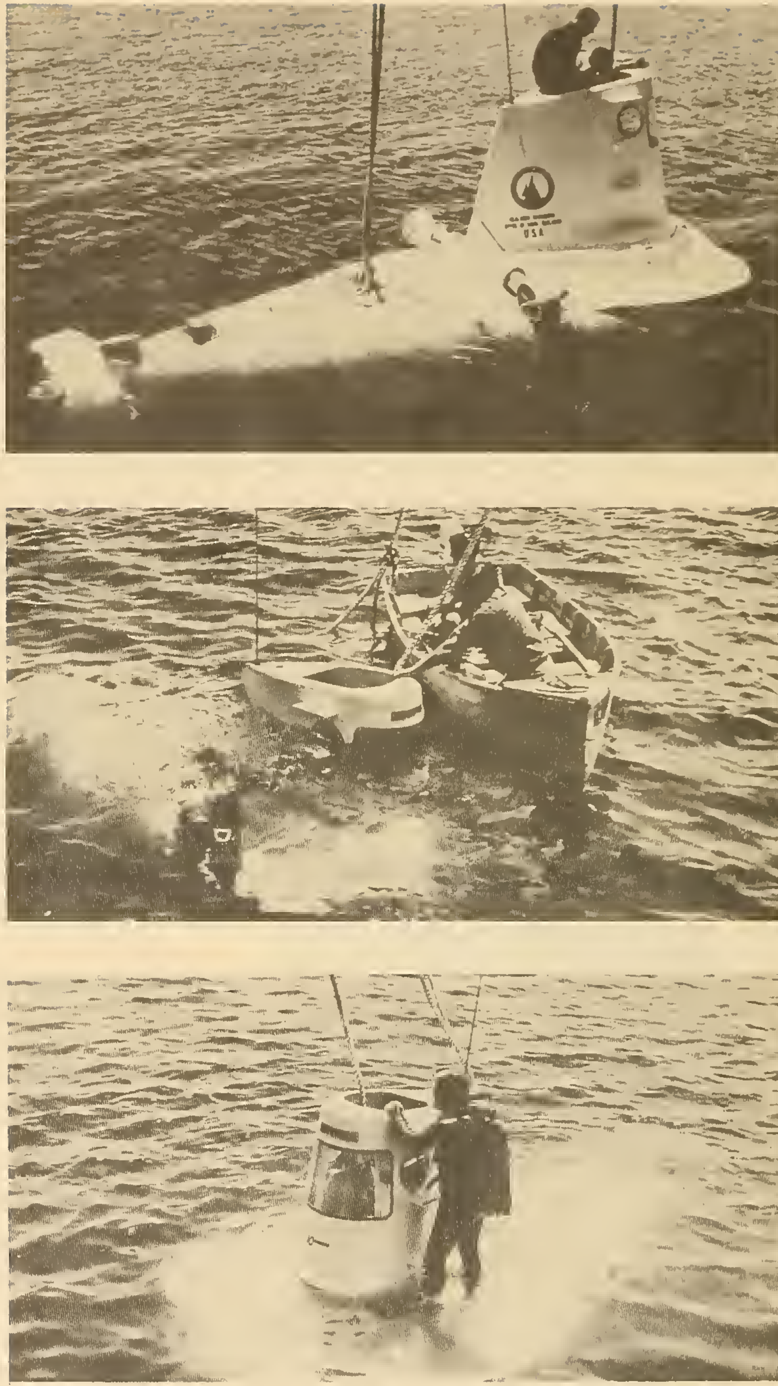
Instruments and Equipment

Instruments and equipment carried aboard ALVIN are used for the control and navigation of the vehicle and for scientific observations.

The control and navigation instruments are the gyro compass and gyro repeater, a back-up magnetic compass, battery voltmeters, ammeters, and ground detector; indicators for depth, speed, list, trim, and variable ballast; a doppler navigation system; and, to be installed in the future, a dead-reckoning tracer. An atmosphere-analyzing system that includes CO_2 and O_2 monitors as well as pressure, temperature, and humidity indicators has been installed also.

An up-and-down-looking echo sounder will give both height above the bottom and depth below the surface. To avoid obstacles, the pilot will not only keep watch at the viewing windows, but will also monitor a scanning sonar set and a closed-circuit TV system. A sonar telephone

WHOI 11.10



ALVIN is operated on ocean surface during recent test.

WHOI 11-61

system will provide voice or code communication with the mother ship, and a marine-band radio telephone will be available for communication when ALVIN is on the surface.

Scientific equipment placed aboard ALVIN for a particular dive will depend, of course, on the special interests of the scientist-observer. The vessel is designed to be versatile with respect to the weight, space, and power requirements of the portable scientific equipment, so that the needs of scientists working in different disciplines can be met. Remaining on the vehicle most of the time will be a remotely controlled mechanical arm and associated sample trays or jars, a precision graphic recorder for the echo-sounder system, underwater cameras and associated strobe and incandescent lights, tape recorders, a precision frequency source for conversion from direct current to 60- and 400-cycle alternating electrical power, and movie and still cameras.

Support Equipment

ALVIN has been designed to operate with a minimum of assistance from large vessels. It will require a mother vessel, however, to lift it out of the water and to provide facilities for charging the batteries and air flasks, for replenishment of the life-support system, and for long-range communications. A catamaran barge utilizing two Navy-surplus floats, each 96 feet long and displacing 400 tons, is being built for this purpose. The barge will have a platform which can be raised to lift the vehicle from the water, and it will have sufficient deck space to mount three portable vans. One of these vans will house diesel generator sets, electrical switchboards, and air compressors. The second van will contain a machine shop equipped with a lathe, drill press, grinder, welder, and miscellaneous tools, as well as spare parts. The third van will house an electrical and electronics repair and test shop; this van also will be used as a dark room and as the communications center. So equipped, the catamaran will not require the services of a large research vessel. Even towing to the operating area can be done by an ordinary tug.

Safety Provisions

Built into ALVIN are certain features which will enable the occupants to return safely to the surface in the event of an accident or malfunction. Each of the three batteries can be dropped to reduce the weight of the vehicle. The trim-system mercury can be jettisoned. The mechanical arm can be detached at the shoulder if it becomes hopelessly entangled. And as a last resort, the pressure sphere, itself, can be disconnected

WHOI 11,12

from the rest of the vehicle; it is positively buoyant and therefore will rise to the surface.

In case a fire breaks out in the sphere and produces noxious fumes, or if the occupants must escape the vessel in relatively shallow water, self-contained underwater breathing gear (SCUBA) is stored for each occupant. Chemical fire extinguishers are carried also.

Testing Program

All of the vessel's components that will be subjected to sea pressure have been tested in pressure chambers to well below the design operating depth of 6,000 feet (2,750 pounds per square inch). These components include the pressure sphere and its windows, electrical penetrators, hatch, and release mechanism; the aluminum spheres required for additional buoyancy and for the variable ballast system; the plastic buoyancy material required for additional lift; and other containers subject to sea pressure. The electrical motors, batteries, switches, pumps, hydraulic motors, and valves, all of which are oil-compensated to ambient sea pressure, have been operated in a test tank at 5,000 pounds per square inch (equivalent to an ocean depth of about 11,000 feet).

A thorough check of all systems was made before ALVIN was first placed in the water, late in June. During these initial sea trials, ALVIN made a successful manned surface run and shallow dive. As the trials continue, at greater depths, the systems will continue to be checked. At the same time, pilots will be trained to handle the vessel under all conditions expected to be encountered.

The testing and training will culminate late this summer in dives to ALVIN'S design depth of 6,000 feet.